THE MACHINE GUN

VOLUME II, PART VII

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THE MACHINE GUN

History, Evolution, and Development
of Manual, Automatic, and Airborne
Repeating Weapons

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PREFACE

The series of books entitled "The Machine Gun" was begun with the belief that the next best thing to actual knowledge is knowing where to find it. The research summarized within the covers of these volumes has been compiled by the Bureau of Ordnance, Department of the Navy, in order to place in the hands of those rightfully interested in the art of automatic weapon design, the world's recorded progress in this field of endeavor.

Part VII of Volume II is devoted to developments in the Soviet Union and her satellites. A study of each progressive step was made in order to ascertain why certain principles were abandoned and the circumstances that influenced any radical change in design.

Inventors and the automatic firing mechanisms they originated are presented in the sequence their devices were adopted by the High Command of the Soviet Regime. Weapons related in operating principles are considered together.

The potentialities and limitations of all basic operating systems of automatic weapons are so well known, that once the all important factor of establishing a trend is accomplished, the most trivial bit of information furnishes a yard stick to measure progress.

While nothing is claimed for this volume except that it is the result of tedious and laborious research, it is believed that in some manner it will help to point the way to a better understanding of past development.

Quotations from actual writings of the inventors, manufacturers, and professional critics are given wherever possible, as well as excerpts from reports and instruction manuals pertaining to specific weapons.

Great stress has been laid upon the inclusion of actual photographs of the guns discussed, thus corroborating the old Chinese proverb to the effect that a picture is worth a thousand words and, in addition, giving the reader an opportunity to view the weapon from the camera's eye and drawing whatever conclusions are pertinent to his interests in examining this volume.

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Frontispiece. Soviet women armorers preparing belted ammunition for a 20-mm. aircraft cannon.

PART VII

WEAPON DEVELOPMENT IN THE SOVIET UNION AND HER SATELLITES

Chapter 1

BACKGROUND OF SOVIET ARMS DEVELOPMENT

Infantry Armament in the Nineteenth Century

By the eighteen sixties, the World powers, including Russia, were becoming interested in new types of weapons to replace the old conventional armaments. This interest was stimulated by our War between the States. During this war, officers of many European countries had visited the United States and had seen all manner of new weapons tried.

At this time and up to approximately the turn of the century, the Imperial Russian Army was almost totally dependent on foreign sources for its infantry armament. In the eighteen eighties, a gigantic order for military revolvers was placed with the American arms producing firm of Smith and Wesson. Instead of with the customary S & W, revolvers were marked with the Imperial double eagle and Russian lettering. Even the 3-line (7.62 mm) Mossin Rifle, Russia's first modern shoulder arms of native design, was originally mass produced at the famous French Arsenal, Chatellerault. (See fig. 1–1.) The use of the measure "line" as a designation of gun bore diameter was abandoned by Russia at the end of the Czarist Regime.

In 1871, General Gorloff was sent by the Czar's government to the Gatling Gun Company plant at Hartford, Conn., on a mission to procure this company's manually operated machine guns, which were constructed to use the cartridge of the Russian infantry rifle. Various contemporary military journals estimated that 400 Gatling guns in all were bought.

The guns were delivered in a few months, and most of them were distributed in the garrisons of European Russia. Some of them were used for the auxiliary armament of fortresses; others were assigned for field service. One battery was provisionally attached to the cavalry for trial purposes. Forty-eight guns were sent to the Caucasus, and 24 to Central Asia.

The guns were all stamped with General Gorloff's name as that of the officer who had superintended their manufacture, with the result that for some years machine guns were known in the Russian Army as "Gorloffs."

In the Central Asia campaigns, the machine guns proved to be highly effective weapons against the mass charges of the Turcoman Cavalry. In the Khiva campaign, on one occasion a section of two guns was the chief factor in repulsing a dangerous attack made by an enormous force of the enemy in the early hours of the morning. The advancing cavalry was barely visible, but the indistinct target was so large that it was impossible to miss. As the stream of bullets tore through the mass of horses and men, the Turcomans were seized with panic and turned to flee, "leaving heaps of their dead in front of the Russian lines."

These guns were later manufactured in Russia. As they were copied from the original weapons bearing General Gorloff's name, the rank and file accepted the gun as being originated by the General.

Introduction of Maxim's Automatic Machine Gun

In the eighteen eighties, Hiram Maxim's automatic machine gun was creating a sensation in military circles in Europe. Arrangements were made for Maxim to exhibit a gun in St. Petersburg before a number of high ranking officers. Many years later, in telling of the incident, Maxim said that they seemed dubious of his gun, and, despite all the accounts previously published in European newspapers, no one present seemed to realize what an automatic gun was. They seemed to think that, like the Gatling, the new weapon required an outside source of operating energy.

When firing commenced, they were astonished to see the weapon fire 333 times in a half minute. Despite the remarkable performance, it was some years before Maxims were purchased and then only in limited quantity.

Figure 1–1. Exhibit in the Museum of the Tula Arsenal on the occasion of its 235th Anniversary. The rifle shown is the early version of the 3-Line (7.63-mm) Mossin, and in the background is the portrait of its designer.

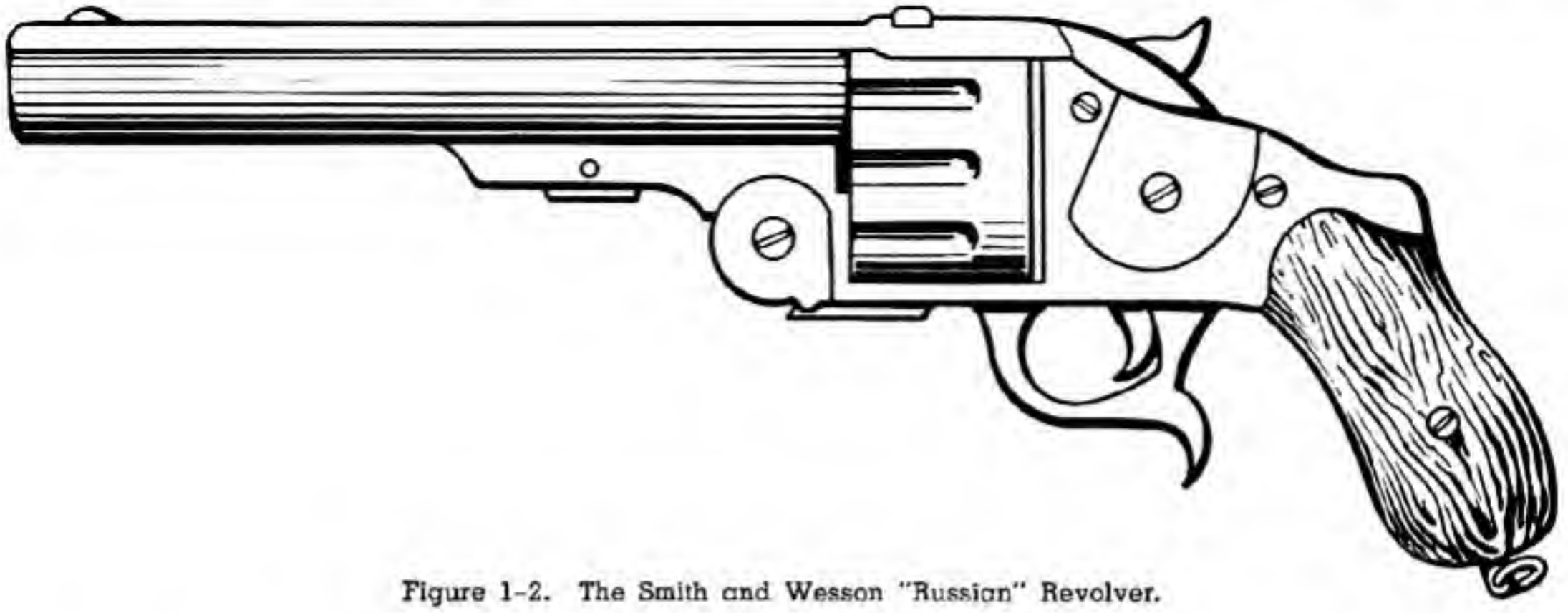

Figure 1-2. The Smith and Wesson "Russian" Revolver.

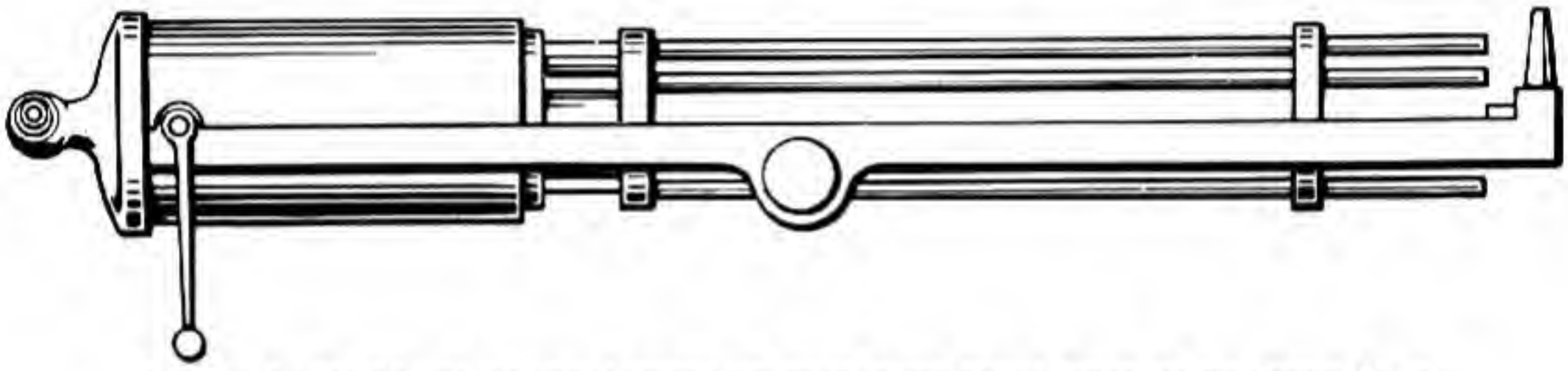

Figure 1-3. The 4.2 Line (10.6-mm) Gatling Gun, made in the United States for the Czarist Army.

During his stay in Russia, Maxim was subjected to police surveillance. It is interesting to note that such methods were applied to foreigners going to Russia even in those times, regardless of the fact that they were invited there by the regime. The president of Colt's Patent Fire Arms Company reported that he was similarly shadowed when he visited Russia shortly before World War I to discuss certain arms matters with the government.

Prior to 1900, there were no organized machine gun units, and no effort had been made to organize them. Literature on machine guns was scanty. The Artillery Administration of the Army, after experiments with both the Maxim and the Hotchkiss, equipped the fortress artillery units with the Maxim.

A certain Colonel Kern prepared a pamphlet on machine guns, which included maintenance methods and a firing chart. He indicated peculiarities of the weapon and discussed methods of correcting them.

The Artillery Administration of the Army worked out detailed sketches of machine parts, as well as sketches of spare parts and accessories. Such sketches were used in the acceptance of guns and

Figure 1-4. The 4.2-Line (10.6-mm) Cartridge, standard in the Russian Army prior to the eighteen nineties.

parts made in foreign countries. Tula Arsenal made barrels for these early Maxims, and some consideration was given to the idea of establishing a factory for making complete guns.

For several years the Maxim was tested for ballistic characteristics at the Artillery Range under the supervision of one Colonel Zhukov. The Colonel later assembled his data into a manuscript, but it was found to be of little use for training field units because of the scientific and technical nature of the treatise.

Manufacture of the Maxim machine gun first began at the Tula Arsenal about 1905. Nothing like mass production was achieved; however, the date is notable, for production of a small lot of the same guns occurred contemporarily in the United States. The American factory which made the Maxim had already made quantities of another automatic gun, and within a few years was producing a third. It was 20 years before any other design than the Maxim was made in quantity in Russia.

An improved version of the Maxim, also produced by the Tula Arsenal, was issued after 1910. The principal improvements were in the substitution of lighter and stronger steel parts for some formerly made of bronze. The action of the gun was unchanged.

Madsen Gun

In the early years of the twentieth century, light machine guns capable of transport by one man began to appear in several countries. Russia was one of the first to put them to use. Small numbers of the Madsen, made in Denmark, were purchased even before the Russo-Japanese War of 1904–5. Cavalry were armed with this gun, for it was well suited for horse transport, while the infantry and fortress units retained the Maxim.

It is indeed remarkable that this arrangement was worked out at a time when other armies were debating the usefulness of machine guns in general, and only a few experts realized that two distinct classes of guns must be provided. Although excellent guns were adopted by Russia, the notorious corruption and inefficiency of the Czar's government in matters of finance and supply prevented the most efficient use of the weapons. Even though it was obvious that Russia could not hope to produce guns in sufficient quantities, purchases abroad were very meager until World War I commenced.

Machine Guns Used From 1900 to 1914

In the Boxer Campaign of 1900, four machine gun units were improvised and sent to the front. Each company had eight guns of the Maxim fortress type, mounted on a limber. These machine gun sections participated in several actions, completing the capture of the Tientsin Arsenal and the Relief of Peking. The international nature of the campaign gave an opportunity for observation of other forces and led to further developments in the use of the Maxim.

In 1901, it was decided to form five machine gun companies for an experimental period of 3 years. These companies were each issued a gun of the same type used in the Boxer Campaign, but later the mounting was improved. Each gun was allotted 36,000 rounds per year. This figure was found to be too small for an adequate program, and almost twice as much ammunition was used. A representative of the Maxim firm, I. K. Miller, gave con-

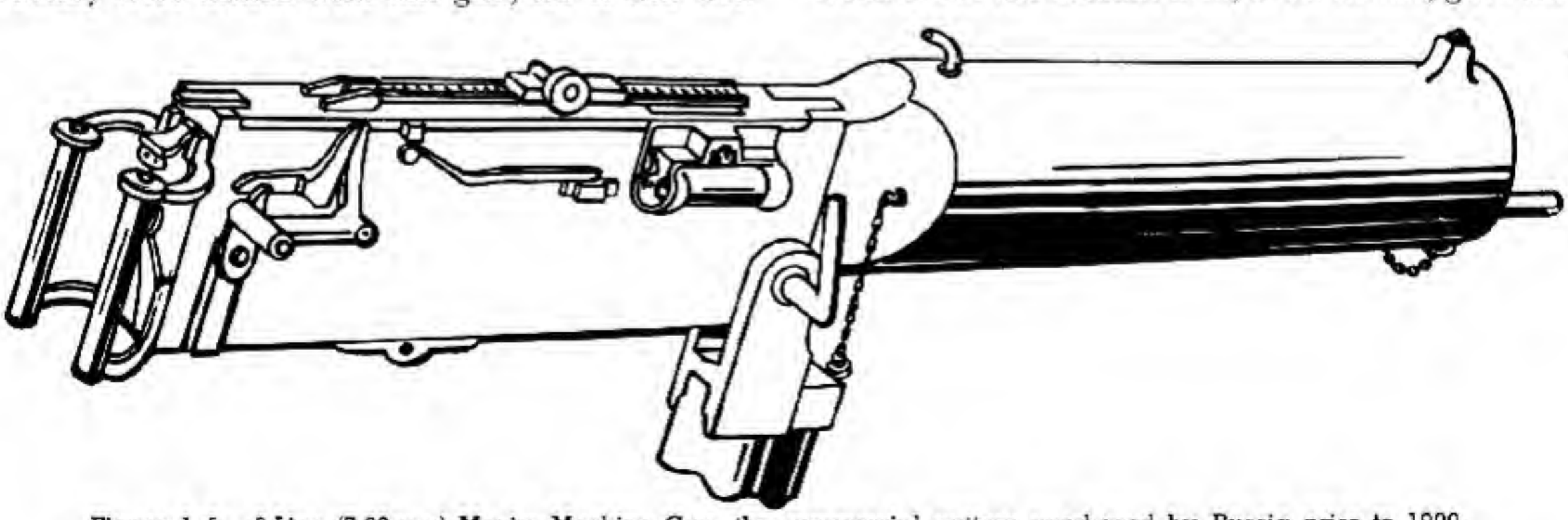

Figure 1–5. 3-Line (7.62-mm) Maxim Machine Gun, the commercial pattern purchased by Russia prior to 1900.

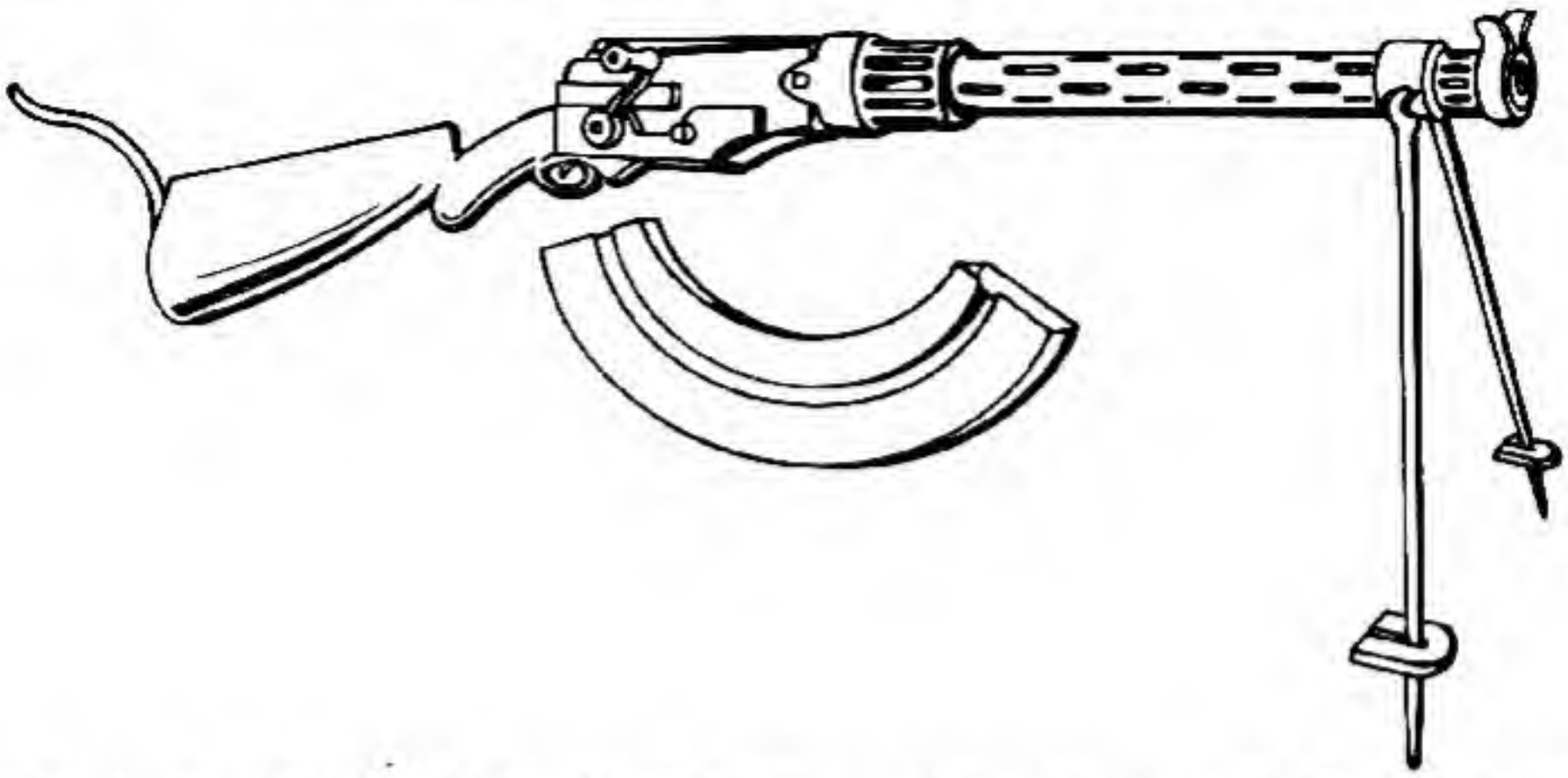

Figure 1–6. 3-Line Madsen Light Machine Gun Model 1902, the commercial pattern imported from Denmark prior to World War I.

siderable instruction to the machine gun personnel. These companies fought in the Russo-Japanese War, along with several newly organized units.

In this war, for the first time, there appeared situations where it was possible to see the destructive effects of the gun when properly used. After the war, there was a complete tactical reorganization of the machine gun units, acknowledging the importance of the weapon. Its tactical employment was officially introduced under War Department Order Number 684 of 1906.

There is no doubt that experimentation with different actions was beginning during this period. However, it is difficult to separate propaganda from history when we consult Russian works on weapon history. The statement that D. I. Mandeleyev, Russian chemist, invented smokeless powder, is certainly in contravention of the facts.

Other more plausible claims are: that V. G. Federov drew up plans to convert the infantry rifle to a semi-automatic in December 1905; that Y. U. Roshchepei, a regimental blacksmith, developed an automatic rifle with a fixed barrel in 1907; and that P. P. Tretyakov and A. A. Pastukov made a light machine gun which competed with the Vickers in tests in 1909. The fact that the Vickers was exhibited in Russia probably inspired the 1910 Maxim. The proving ground at the Officers' School at Oranienbaum was the place where foreign arms were tested, and several of the men who later became important designers in the Soviet Regime were stationed there before World War I.

Weapons Used in World War I

Desperate shortages of arms occurred in Russia soon after World War I began. Agents were sent to various friendly or neutral countries to buy weapons to bolster the sagging armies. Machine guns were extremely difficult to obtain, for most of the producing nations were in the war at the outset. France and England supplied some; but soon Russia, like several other nations turned to the United States for supplies. The Mossin was manufactured in the United States repeating the history of the Russian arms shortage at the end of the nineteenth century when this rifle was manufactured at Chatellerault. The Colt Company began making Vickers machine guns chambered for the 7.62-mm Russian cartridge. A large order was given to the Marlin-Rockwell Corporation of New Haven, Conn., for the Colt gas-operated machine gun, and 40 inspectors were needed at the plant to accept the finished guns.

In addition to the guns made at home and those purchased, all captured guns were used, but even then there never was a sufficient supply. During the 2 years of civil war after Russia withdrew from the war against Germany, a Russian named Federov designed an automatic shoulder rifle of which only a few were used. In the development of ordnance, the civil war was of principal importance because the Soviets had an opportunity to acquire "Imperialist" weapons for study, the White Armies having received considerable supplies of arms from the Western Powers.

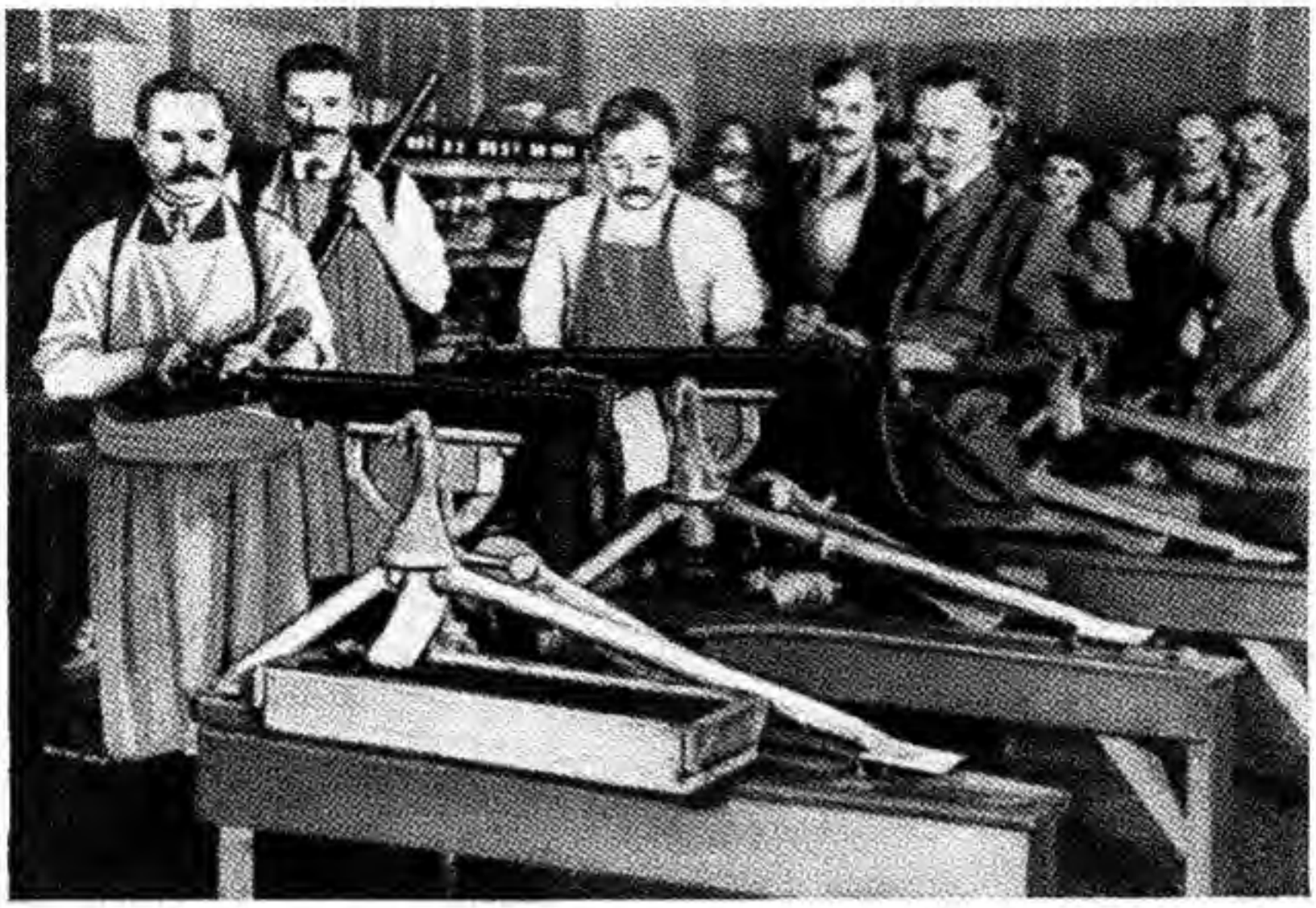

Figure 1-7. In World War I, Russian Inspectors at the Marlin-Rockwell Corporation, New Haven, Conn. Guns being accepted are the old Colt-lever type.

Development of the National Armament Industry

When the Soviet finally made peace with their many enemies, their forces were still armed mostly with foreign arms. The Federov automatic shoulder rifle had been only moderately successful. The Russian military press itself has since admitted that the mechanism was entirely too complicated. A nation that continually shouted to the World that Communism and Capitalism cannot live together needed something to back up its doctrine.

In the early nineteen twenties, a decision was made to develop a strong, self-contained national armament industry during the first Five-Year Plan. One of the initial steps was the establishing of the Design Office in 1924, in a small building at the Kovrov Machine Gun Factory. The chief was V. G. Federov, and he selected for his chief assistant V. A. Degtyarev. These men had worked together at the Sestrorets Small Arms Plant when the Federov automatic shoulder rifle was made and on the proving ground at Oranienbaum, where finished weapons were tested.

At its inception, the Design Office had several skilled machinists and eight machine tools. This was the real beginning of the automatic weapon industry in the U. S. S. R. Small as it was, this office was the forerunner of the Fourteenth, Fifteenth, and Sixteenth Bureaus of the Ministry of Armaments, which supervised the design and production of at least a million machine guns in World War II.

At the same time the Design Office was established, the U. S. S. R. was still an agricultural nation. The failure of "War Communism" even to feed the people during the various wars from 1917 to 1921 had necessitated a change to a "New Economic Policy." This NEP, as it is often abbreviated, had the effect of legalizing small businesses; under it, the government also granted several valuable concessions to foreign capitalists. The NEP did not further the armament industry, however, since it was in effect only a policy for the production of consumer goods. Consequently, it was supplanted in October 1928 by the first Five-Year Plan.

This plan, though widely heralded as intended to improve the lot of the masses through industrialization, was actually a thinly disguised scheme to establish a strong armament industry. The 4¼ years that this plan was in operation placed heavy burdens on the people, for all efforts were concentrated on industry. Many warlike slogans made their appearance and were adopted, emphasizing the hostility of the outside world. When the pro-

Figure 1-8. Soviet small arms designers Tokarev and Degtyarev, in uniform, as deputies of the Supreme Soviet of the U. S. S. R., in March 1941.

gram terminated at the end of 1932, the goals previously set had not been reached, but remarkable design progress had been made in various lines of military equipment.

Several existing circumstances served to further the ambitions of the Soviets. The complete domination of the people by the regime assured that any needed effort could be channeled to the proper place. The friendship with Germany in the early nineteen twenties, although short-lived, provided help and guidance of incalculable value. Throughout the world, tireless party members were seeking out and forwarding every scrap of military information they could get their hands on.

Communism recognizes no property rights in regard to foreign patents, accordingly, many of the world's inventors saw their ideas used by the Russians without compensation. However, since information disclosed in a patent may be insufficient for evaluating a piece of ordnance, from time to time efforts were made to purchase individual pieces of promising automatic firing mechanisms from the manufacturer. At the same time, however, every effort was made to keep information on Russian weapon progress from reaching the outside world.

It was indeed fortunate for the Soviet that the first Five-Year Plan progressed in a peaceful period. The Russians engaged in one minor clash with China in 1929. Otherwise, there was no warfare involving their forces, so it was possible to work patiently and unhurriedly on a Degtyarev design, which seemed the most promising of those so far tried. A need for independent testing facilities led to the use of several research organizations. This policy was in direct contrast to the situation in the old army, where testing was carried out any place that was available, with or without scientific assistance.

One of these research organizations was the NIAP, or Ordnance Department Proving Grounds, which was attached to the Military School KUKS, meaning Kursy Usovershenstvovaniya Komendnago Sostavs or School for Improvement of Qualifications of Commanding Personnel of the Red Army. The NIAP was located at Solnechnogorsk, 75 kilometers Northwest of Moscow, on the Moscow-Leningrad Railroad. The proving ground was established there about 1926, after being removed from the vicinity of Novo Gireevo, which was a station on the Moscow-Kursk Railway, 14 miles from Moscow.

The equipment at the disposal of NIAP was relatively poor compared to West European and American laboratories, but it was better than in other Soviet research organizations. It consisted of a few ordnance testing devices, such as instruments for calculating rate of fire, pressure gages, interior barrel gages, and devices for measuring velocity. NIAP had neither piezoelectric quartz apparatus for measuring pressure inside the gun barrel nor equipment for testing the quality of the metal.

The school had no technical or pyrotechnical laboratories; however, it proved to be a good mechanical workshop which was used principally for the production of trainee equipment. The personnel was relatively large, fluctuating between 60 and 150, since almost the entire teaching staff of the KUKS School participated in the work.

NIAP was engaged in work for the more important small arms manufacturing plants, and also on special tests for the Ordnance Department of the Army, the Research and Development Section of the General Staff, and on special assignments for the Commissariat of Defense.

While trying to improve the Degtyarev light machine gun, the NIAP also worked on correcting the design of the pointed nose type bullet. This work was in collaboration with the Artillery Academy, the NIIS–OAKh, and the laboratories of the Shostenski power plants. The performance of this bullet had never been particularly good. In the course of the Civil War and Revolution that followed, it had degenerated through poor manufacturing to such an extent that it could not even be used for target practice or training exercises. As a result, all firing of any importance, such as tests or competitions, was carried out with American manufactured cartridges, mostly the Remington, which coincidentally had been left over from the huge orders placed during World War I.

The first Soviet-made cartridges which could be considered fairly satisfactory bear the identification 1925 on the aft end of the case. At that time (1925), small orders for ammunition for the Russian rifles were placed with American firms—Winchester, Remington, and Peters. Powder similar in type to that used in American cartridges (duPont powder), was made by the Soviet and has been used

since then for loading their cartridges. The switch from black powder (carbon sulphur base) to smokeless powder for the Nagant revolver model 1895 was made about the same time. However, no special propellent for revolver cartridges has been developed; pyroxylin powder for hunters' shotguns (Model Glukhar) was used, though hardly suitable for revolver cartridges.

Another organization known as the NIIS TsS OAKh collaborated with NIAP on the improvement of rifle and revolver ammunition. After 1928, NIAP worked with the Tula Arms Plant in modernizing the Russian combat rifle 1891 model and in constructing a new military cartridge for the medium machine gun. The latter was similar to the German "SS" (heavy pointed bullet with metal jacket). These efforts resulted in the development of a modernized rifle, model 1891–1930, and a model 1930 heavy cartridge for mounted machine guns. During this period, NIAP branched out and devoted much time and effort to testing machine guns for airplanes, tanks, and other special purposes.

The NIIS OAKh (Scientific Research Station and Proving Grounds of the Central Council of Oscaviakhim) was located near Kuskovo, South of Moscow. This is the scientific research station and proving ground of the Oscaviakhim.

The ostensible aim of the NIIS OAKh (Nauchno-Ispytatelnaya Issledovatelskaya) was to serve the requirements of civilian groups engaged in recreational rifle and pistol shooting. However, as the sport was actually a means of training in Army practices and as Army weapons were used to a great extent, the work of this research laboratory had a definite military slant.

This station began its operation about 1927. It was organized by A. A. Smirnsky, sportsman and marksman, and a former artillery officer in the Czar's Army. In 1926, Smirnsky was attached in some more or less minor capacity to the staff of the Red Army; later he became a permanent consultant and an active worker at the NIAP.

The confusion which existed at the Oscaviakhim characterized operations at the proving ground. During the period from 1927 to 1941, NIIS changed directors ten times. There was one year when three different directors succeeded each other, and the following year there was no director at all. These head men were sometimes engineers, often students, and in some instances half-educated enthusiasts engrossed in a hobby. Notwithstanding this chaos, the organization achieved substantial results, thanks to the near fanatical enthusiasm of some of its members.

From 1927 to 1928, NIIS was engaged mainly in improving the quality of combat and small caliber cartridges (22 long rifle). At the shooting competitions which took place between 1927 and 1932, cartridges loaded at the NIIS Testing Station were used almost exclusively. NIIS ordered powder, cartridges, and arms from western Europe and America and tested them. They also kept in constant contact with the cartridge plants in Tula, Lugansk, and Kuntsevo.

The laboratories of the NKVD Sports Organization Dinamo also engaged in the study of ballistic matters; however, a discussion of their work is not pertinent here.

The largest proving ground of the USSR was located at Anapa in the Crimea, on the shores of the Black Sea. There the Artillery Academy conducted tests of machine guns and pistols. The principal work was in the field of exterior ballistics. From 1928 on, the testing laboratory worked out procedures for maintenance of weapons. Each year up to World War II, the laboratory published some new "temporary" rules for the maintenance of arms.

A small reference library was kept at Anapa. It included documents provided by the Intelligence Service, official military handbooks of foreign powers, and "capitalistic" magazines and books concerned with arms and ammunition.

The second Five-Year Plan was proposed in December 1933 and ratified in early 1934. As far as automatic weapons were concerned, the first plan had been concerned mostly with research and development. The second included the etsablishment of new production facilities, as well as progress in design work of Soviet machine guns of larger-than-rifle caliber. While the arsenal of Tula continued to produce several different types of guns, varying from the oldest model to the most recent design, a new works called the Voroshilov Factory, at Kolomna, was put into operation.

From 1931 to 1933, a number of experimental automatic rifles by Tokarev, Degtyarev, and others were tested at NIAP. Pistols and submachine guns

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were also under trial, but little interest was shown in the latter until the Gran Chaco War in South America. After that, a Russian design was improved and introduced into the Red Army.

The years 1934 and 1935 were devoted mainly to efforts to improve the rifle cartridge, which performed very poorly in a certain new machine gun. From 1935 on, NIAP was busy testing machine guns, anti-tank guns, mortars, automatic and semi-automatic rifles, and, after the Finnish War, submachine guns.

At the same time, NIIS was similarly concerned with ammunition problems, and it also developed a model of a sniper's rifle and conducted a school for teachers of sniping. Methods of training riflemen and standard designs for rifle and machine gun ranges were worked out. A small caliber machine gun for training purposes was developed, as well as several small caliber rifles and pistols.

Theoretical calculations concerning aircraft armament were in progress at the Central Aero-hydrodynamic Institute, and the practical tests were performed at one of the proving grounds assigned to these programs. This Institute had excellent personnel and equipment, the mere fact that it concerned itself with aircraft armament was considered secret. It was still engaged in this work when the second Five-Year Plan ended in December 1937.

In 1938, when the third Five-Year Plan commenced, all Europe was feverishly preparing for war. This period is marked by Soviet concentration on aircraft weapons, especially the heavier calibers. They utilized experience furnished by the Spanish Civil War, as did the other nations which sent observers to Spain. The slow development of the heavy Russian aircraft guns may be accounted for by the necessity for developing suitable ammunition.

Figure 1-9. Hero of Socialist Labor Boris Gabrielovich Shpitalny, automatic weapons designer, at his drawing board.

Shpitalny

In the late nineteen twenties, Boris Gabrielovich Shpitalny designed a lightweight, high-speed, rifle caliber aircraft machine gun in collaboration with Komaritsky. The design was enthusiastically received and led to Shpitalny's appointment as Chief of OKB 15 (Special Construction Bureau) in the Ministry of Armaments.

Born in 1898, Shpitalny was associated with the Bolsheviks. He was known as a hero of socialist labor from the time of the overthrow of the Czar. He is acclaimed as an instructor in the Red Army, as one of Russia's most prolific designers of automatic weapons, and as author of several books on small arms.

His early association with the Bolsheviks gave Shpitalny a distinct advantage. He was given every opportunity by the new regime to carry on in his chosen field. He developed to the fullest his natural aptitude in the design of automatic firing mechanisms.

Boris Gabrielovich Shpitalny was 1 of the 12 men recognized by the government to carry on development immediately preceding World War II; for his work in this field he was awarded the Stalin Prize, first class.

In 1935, Shpitalny was decorated for the successful design of a machine gun. In 1936, he was appointed Chief of the Special Research Bureau for the Development of Automatic Weapons. However, from 1936 through 1943, Shpitalny produced nothing original; by the time World War II had reached the halfway mark, he was beginning to be considered by qualified circles as a "has been." The lightweight, high speed machine gun that he designed had by then been improved repeatedly, and though it was the most widely used during the early stages of aircraft arming, it became less important as the trend became more pronounced toward larger bore automatic guns.

Shpitalny, always the student, then began to be heard of in an academic way; more so than from any notable achievement in weapon design. He held titles such as Doctor of Technical Science in the Ukraine Academy and Chief of Chair of the Ukraine Correspondence Polytechnic Institute. The Academy of Science of the U. S. S. R. lists his name among the candidates for the title of Academician.

While the machine gun that Shpitalny helped to produce had too many features that had been used for half a century to allow it to rise to the dignity of invention, it most certainly was a very noteworthy step in the right direction.

After being brought to the realization that the small rifle caliber machine gun was fast being outmoded by the demands in aviation for a weapon employing an explosive projectile, Shpitalny attempted what practically all other Russian inventors have tried, that is, scaling up the dimensions of a successful rifle caliber machine gun until it fills the needs at hand. The large bore automatic firing mechanism that resulted did not prove successful.

Beresin

Another automatic firing mechanism, comparable in importance to the Shpitalny, is associated with the name "Beresin."

Mikhail Ergenievich Beresin served as a designer on the staff of Tula Arsenal. For his work, he was rewarded with an important post in Central Construction Bureau Number 14. This Bureau is credited with making and sponsoring the improved version of this gun, which appeared soon after World War II began.

Wehrmacht Attack

When the Wehrmacht attacked, machine gun production was concentrated in three factories, Number 2 at Kovrov, Number 366 at Tula and Number 74 at Izhevski. In the course of the war, Tula and Kovrov were evacuated. Tula joined factory Number 66 at Slatoust-Urzhumka, which made the old reliable Maxim. New factories were established at Kuibyshev and Stalinsk. By the end of 1942, Tula and Kovrov were reoccupied. The Russians never revealed even to their allies what shortages existed in their armies. The most revealing information was gathered early in the war by the German Intelligence through tales told by deserters.

Figure 1-10. The Russian Maxim Machine Gun on ski transport, as used in the U. S. S. R. invasions of Finland in the nineteen forties.

Lend-Lease

A vast quantity of material was given to Russia by the Allies; its ultimate disposition is unknown. At the time when the United States was shipping gigantic supplies of ordnance, an American officer of considerable determination, who handled certain lend-lease shipments, managed to obtain a Degtyarev light machine gun, a rifle, and one or two light tanks for the Army's Foreign Ordnance Collection, located at Aberdeen, Md. The Russians attached to the gift a stipulation that no test of the equipment was to be made by the United States. When a Russian liaison officer at Aberdeen Proving Ground at a later date noticed a piece of armor had been removed from one of the tanks for analysis, he protested violently. Yet Russian officials never seemed embarrassed to ask for specimens of our most secret ordnance, always using the pretext that it would greatly aid their war effort. Actually, of course, such material was wanted for long-range development projects, and it was in no way associated with actively carrying on the war. Sometimes the Russians got what they asked for.

Soviet Production in 1944

During the later days of the war, Soviet production began to recover from the Wehrmacht attack. Substantial levels were reached by the year 1944. Soviet sources show the following production figures for 1944 for various types of guns. Later chapters give details regarding each weapon listed here.

Weapon:	*Quantity*
Maxim	270,000
Degtyarev Infantry	120,000
Degtyarev Tank	40,000
Degtyarev-Shpagin Heavy	50,000
Goryunov	10,000
Shkas	40,000
Beresin	60,000

Types of Soviet Aircraft Armament in World War II

An official Soviet publication dated 1943 includes a table of data which coincidentally summarizes some of the intelligence presented in this and the chapters that follow.

A translation of the table follows. A table in chapter 9 shows the Russian characters indicating

Basic Data on Soviet Machine Guns and Cannon Used for Arming Airplanes of the Air Force of the Red Army

Designation data	Designations of the Machine Guns										
	7.62-mm machine gun Shkas			12.7-mm machine gun of one Beresin system			20-mm cannon Shvak			23-mm gun VYa	37-mm gun
	Turret	Wing	Synchronized	Turret	Wing	Synchronized	Turret	Wing	Engine		
Caliber (mm)	7.62	7.62	7.62	12.7	12.7	12.7	20	20	20	23	37
Rate of fire (shots/min)	1,800	1,800	to 1,500	800–1,000	800–1,000	800–1,000	700–850	700–850	700–850	550–650	220
Initial speed of projectile (m/sec)	820	820	840	840 860	840 860	840 860	815	815	.....	910–920	900
Initial speed of projectile (ft/sec)	2,638.4	2,683.4	2,748.8	2,748.8 –2,814.2	2,748.8 –2,814.2	2,748.8 –2,814.2	2,667.05	2,667.05	.....	2,975.7 –2,008.4	2,843
Total length (mm)	952.5	932	1,097	1,397	1,397	1,397	1.726	1,679	2,122	2.145	.....
Total length (inches)	37.5	36.69	431.5	55	55	55	67.95	66.1	83.54	84.44	.....
Weight (kg)	10.6	9.8	11.1	21.431	21.412	21.438	42	40	44.5	66	161
Weight (lb)	23.32	21.56	24.42	47.15	47.1064	47.16	92.4	88	97.9	145.2	354.2
Average weight of cartridge (grams)	23	23	23	130	130	130	185	185	185	467	720
Weight of link (grams)	10	10	10	37	37	37	38	38	38	94	.....
Force for extraction of cartridge from link (kg)	6–13	6–13	6–13	8–16	8–16	8–16	3–6	3–6	3–6	20–30	.....
Force for extraction of cartridge from link (lb)	13.2 –28.6	13.2 –28.6	13.2 –28.6	17.6 –35.2	17.6 –35.2	17.6 –35.2	6.6 –13.2	6.6 –13.2	6.6 –13.2	44–66	.....
Force for discharge (kg)	8–12	.....	.....	8–10	10–12	10 12	8 10	10 12	8 10	11 15	.....
Force for discharge (lb)	17.6 –26.4	.....	.....	17.6–22	22 26.4	22–26.4	17.6–222	22–26.4	17.6–22	24.2–33	.....
Force for reloading (kg)	76–106	.....	.....	100–120	100 120	100–120	.....	.....	.....	67 70	.....
Force for reloading (lb)	167.2 –233.2	.....	.....	220–264	220–264	220–264	.....	.....	.....	147.4 –154	.....
Pressure of compressed air in cylinder of pneumatic reloader in atmospheres (kg)	.....	.....	.....	.....	.....	.....	.....	.....	.....	30–35	.....
Pressure of compressed air in cylinder of pneumatic reloader in atmospheres (lb)	.....	.....	.....	.....	.....	.....	.....	.....	.....	66 77	.....

Figure 1-11. The Soviet DT Machine Gun. In 1944, production of this weapon reached a rate of 40,000 guns yearly.

inventors' names and technical identifications such as turret, wing, and synchronized.

Earlier than 1944, Germany had accurate information concerning not only Soviet weapons and ammunition, but also those of Great Britain and the United States. The insides of the front and back covers of this book show wall charts captured in a German ordnance school in 1944. The chart in the front of the book shows types of aircraft weapons which were advanced models at this time; the chart in the rear of the book shows the types of aircraft ammunition used in World War II by the three countries mentioned.

Soviet Armament After World War II

As a result of the downfall of Germany and the occupation of some of her important factories by the Russians, the latter are today in possession of complete data on both production and experimental German weapons.

From time to time, reports of manufacturing of machine gun material in the Russian Occupied Zone have been issued. Such material might well include replacement parts to maintain existing stocks, as well as manufacture intended to result in new guns. Even more important are reports concerning the work of German ordnance engineers who have gone

over to Russia, either voluntarily or under duress.

In addition to their own industry, the Soviets have several of the world's most famous factories under their control today. These include: two German firms, Walther and Haenel; the Austrian Steyr Works; the "Danuvia" arsenal, at Budapest; the Skoda heavy ordnance plant and the company producing the Brno ZB Machine Guns, both of Czechoslovakia. Many other factories of lesser importance are also controlled, and they provide a valuable addition to the Soviet armament industry.

Weapons developed by some of these countries have vitally affected the pattern of Russian machine gun development in ways that are suggested in this Volume and Volume I in the chapters on Brno ZB and Skoda. The work of the Walther, Haenel, and Steyr firms in pistols, submachine guns, and rifles are outside the scope of these volumes and, accordingly, are not included.

In the pattern of Russian machine gun armament there is a distinct trend, just as there is in every field of Soviet endeavor. In Russia, even as in "capitalistic" lands, successful ordnance inventors are well rewarded for their services. The fact that a design may incorporate pirated features is no hindrance as long as the gun succeeds in combat. After 20 years, during which gas operation dominated the scene in the latter part of World War II, a new group of designers became prominent after introducing a mechanism powered by the forces of recoil. The most important of these is Alexander Emmanuilovich Nudelman, Armament Engineer in the Sixteenth Bureau of the Ministry of Armaments.

Summary

As a vast, continental land power, Russia has always relied on a huge ground Army for both offense and defense.

While during the later years of World War II their Navy and Air Force got greater attention than in previous wars, the Army was still the dominant component of the Russian Military Machine, and its needs dictated the design of weapons.

The background of the present Soviet War Machine (officially created on 23 February 1918 as the Red Army) must be understood to appreciate the great strides made during its 34 years of existence. During the nineteen twenties, the Red Army was thoroughly reorganized. In spite of the changes made, which included intensifying political education, top commanders continued to have little authority.

By 1925 a general plan for standardization of arms and equipment was adopted, with weapon design incorporated with plans for the future. In 1937 the great purge of the military took place. Many of the top leaders were victims. As a result of these mass killings in their own ranks, the officer corps severely limited their own scope of action.

Most of these purges took place under Marshal Voroshilov, the then Commissar of Defense (1927–40). Marshal Timoshenko, who succeeded Voroshilov, continued the reforms but gave the loyal military more authority. The most outstanding change was abolishing the Political Commissar in order to give the unity of command to the military leaders. This revolutionary act was possible because of the great prestige enjoyed by Timoshenko, who had distinguished himself by breaking the Finnish Mannerheim Line.

On 19 July 1941, less than a month after Germany launched her invasion of the Soviet Union, Stalin assumed the position of Commissar of Defense and at once reinstated the Office of Political Commissar. The latter change was doubtless brought about by the near hysteria of the people over the daily retreats of the Red Army. This order was revoked by October of the same year.

By this time weakness of the cumbersome Soviet Military Machine was revealed as was the dire need for up-to-date weapons, especially machine guns. Earlier measures for raising the general level of education were beginning to show results in the increased number of technically trained personnel. The "smashing" tactics toward the old technical intelligensia had changed to a policy of conciliation and solicitude in cases where the intellectuals had turned toward the Soviet power. These changed conditions brought on changes in organization from the high command down to the designers and the smallest manufacturers.

Emerging victorious from the War in Europe, the Soviet military machine was a huge infantry-artillery army, with little emphasis being placed on large mobile units. However, in her campaign against the Japanese in Manchuria, Russia showed the world that she was capable of flexible and expedient handling of large mechanized forces, and a few new

or modified weapons were revealed, showing signs that automatic armament design was being synchronized with this type of warfare and breaking away from merely scaling up or scaling down to meet a requirement.

In 1946, the Soviet High Command reorganized the entire structure of the Armed Services. The Army, including its own Air Force, and the Navy and Naval Air Force were coordinated into a single Ministry of Armed Forces, with the former Red Army General Staff becoming the Armed Forces General Staff. In other words, the Army high command took over the other branches. At this point there was little resemblance between the horse drawn, carelessly trained and led Red Army of 1939.

During World War II, Russia had resources and time to produce only already existing weapons that were basically simple in design; but with the surrender of Germany and the taking over of the great manufacturing arsenals of her Satellites, Russia entered into an entirely new phase of weapon development. The new program is without parallel in military history. Only a few phases of it can be mentioned at this time.

Russian realism in dealing with the educational background of the masses is worthy of note. The simplicity of the designs of the Soviets' automatic weapons reflects an attempt to have modern and reliable weapons in spite of the fact that the soldiers have little background in operating and maintaining any type of mechanical device.

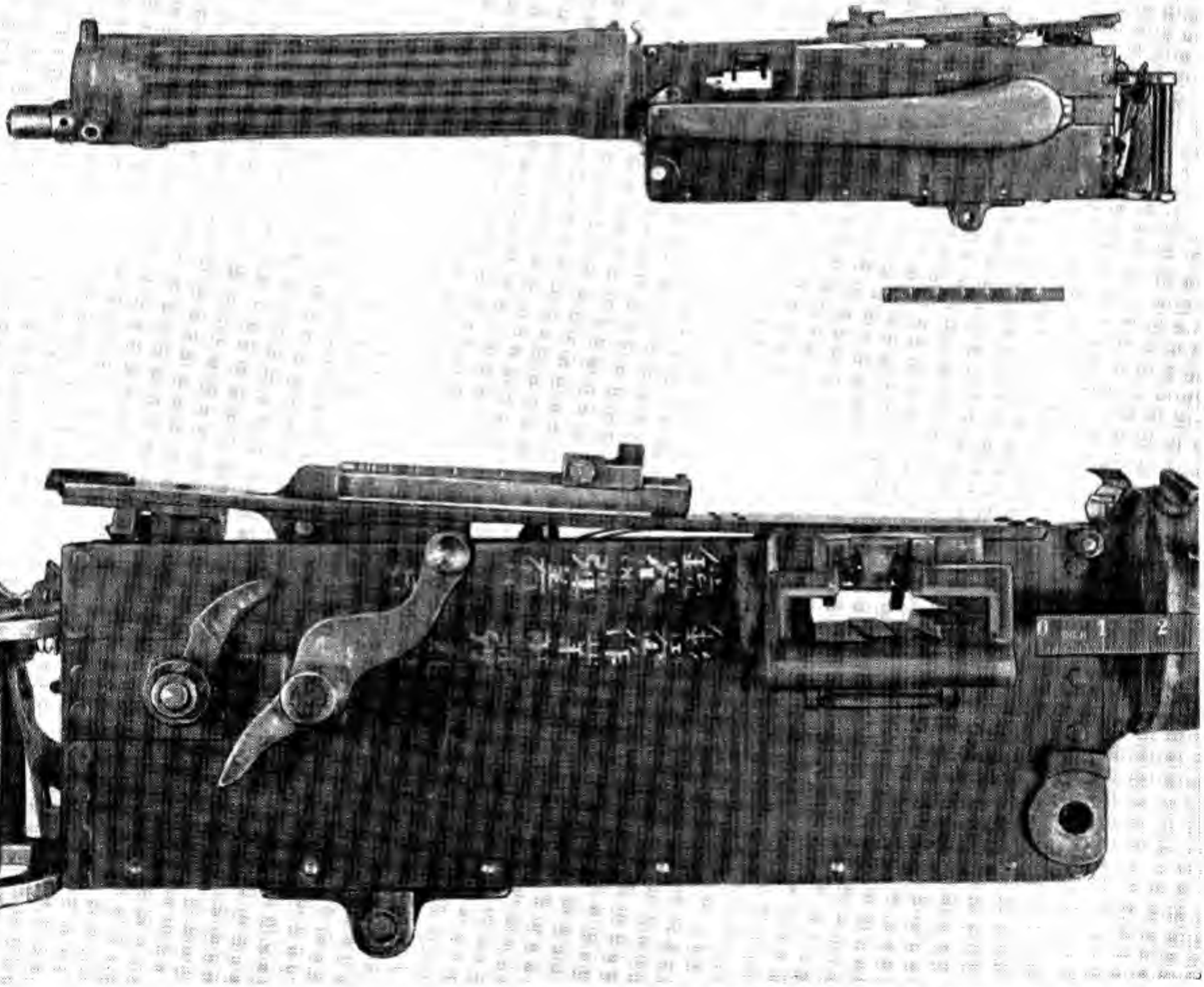
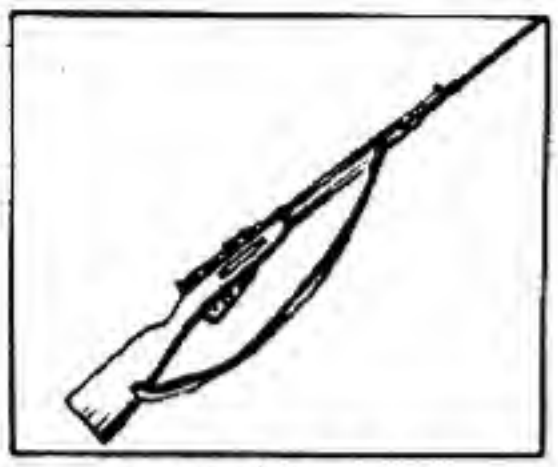


Figure 1–12. Russian Maxim Machine Gun, Model 1910, captured from Chinese Communist Forces in Korea.

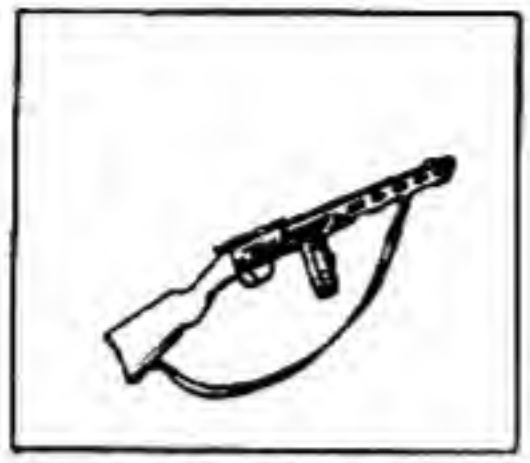
Таблица 28.

СОВЕ́ТСКАЯ А́РМИЯ *(22)* И ВОЕ́ННО-МОРСКО́Й ФЛОТ *(23)*.

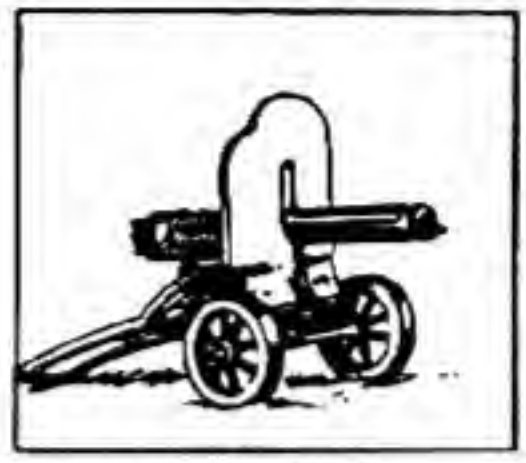
ВООРУЖЕ́НИЕ *(24)* И СНАРЯЖЕ́НИЕ *(25)*.



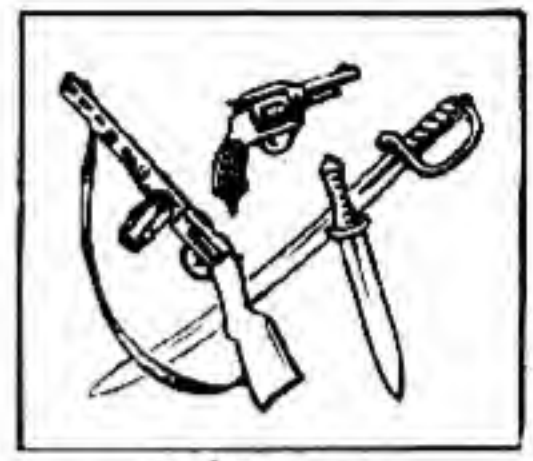
ВИНТО́ВКА *(1)*.



АВТОМА́Т *(2)*.



ПУЛЕМЁТ *(3)*.



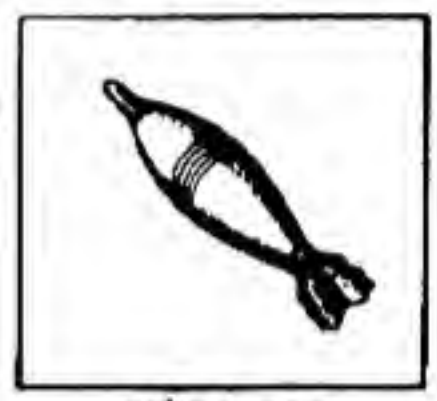
ОРУ́ЖИЕ *(4)*.

ПАТРО́Н *(5)* И ПУ́ЛЯ *(6)*

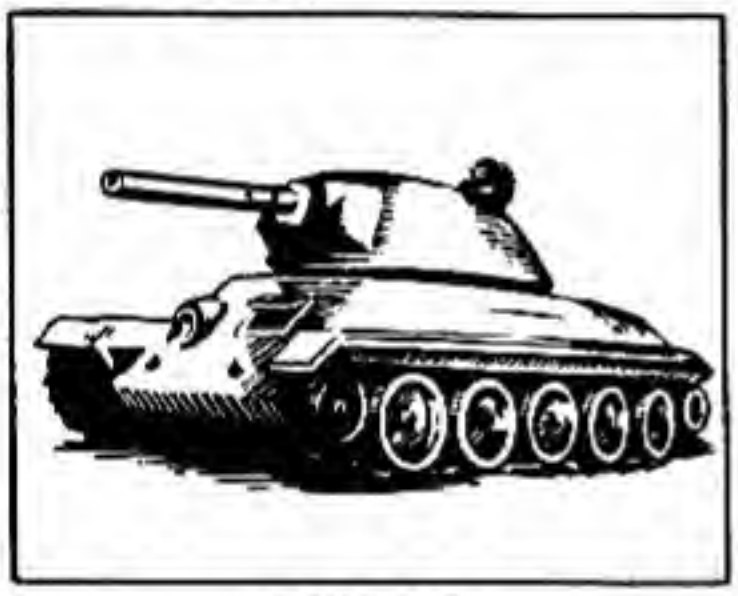
БО́МБА *(7)*.

СНАРЯ́Д *(8)*.

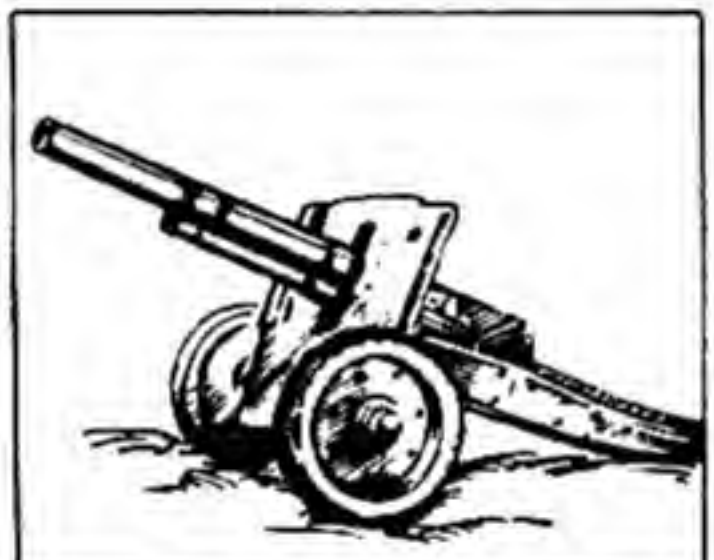
ГРАНА́ТА *(9)*.



МИ́НА *(10)*.

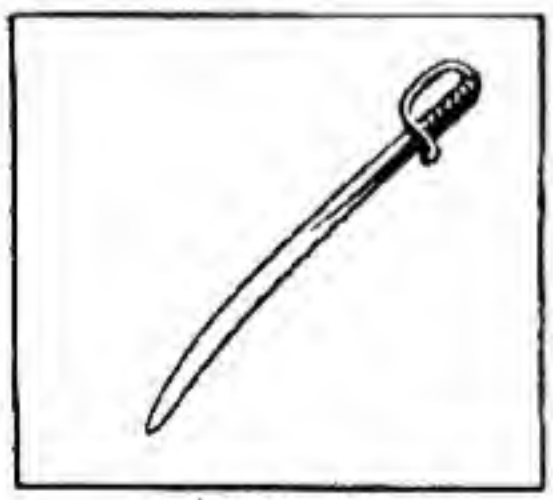


ТАНК *(11)*.

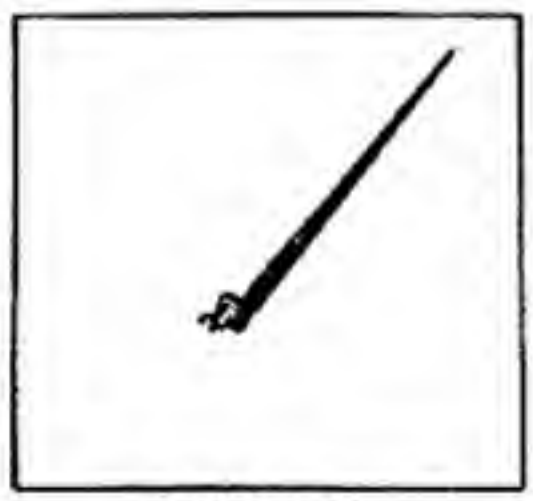


ПУ́ШКА *(12)*.

МИНОМЁТ *(13)*.



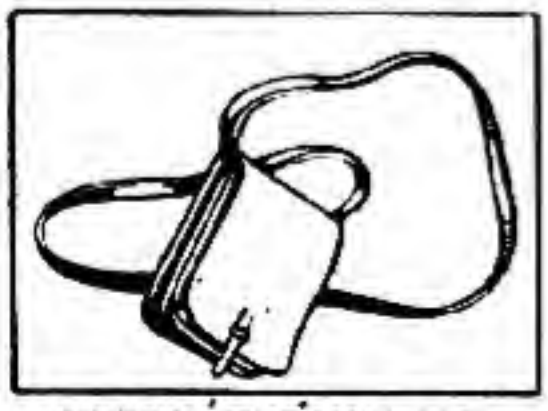
САБЛЯ *(14)*.



ШТЫК *(15)*.

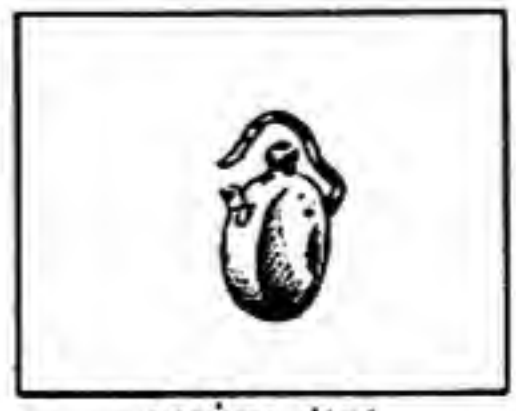
КИНЖА́Л *(16)*.

РЕВОЛЬВЕ́Р *(17)*.

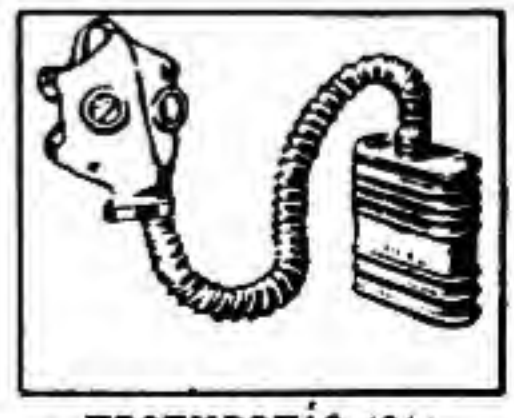


ПОЛЕВА́Я СУ́МКА *(18)*.

КОТЕЛО́К *(19)*.



ФЛЯ́ГА *(20)*.



ПРОТИВОГА́З *(21)*.

Figure 1–13. Page from a Soviet primer published in 1950.

In training Soviet and Satellite personnel the problem of inexperience is combined with that of illiteracy in any or in a common language. One outstanding solution to this problem is suggested by figure 1–12, which shows a Soviet Maxim machine gun which was captured from Chinese Communist Forces in Korea. Painted on the side of the receiver is critical information, basic to the reliable functioning of the weapon. The fact that the gun was being used by Koreans indicates the wisdom of depending on a few simple words, presented so that they cannot be lost, to inform personnel on the use of the gun.

Another aspect of dealing with the educational background of the masses involves manufacturing specifications. The Soviets have taken into account the lack of skilled labor and the lack of equipment to produce machined surfaces and finishes; accordingly weapons are designed to require a minimum of moving parts and fine finishes.

Whether or not these requirements of simplicity and ease of manufacture will apply to another generation is a matter of conjecture. Soviet educators are pursuing some of the latest educational trends in preparing text books, as illustrated by the page from a Russian primer published in 1950, shown in figure 1–13. It is interesting to note that the Communist children are learning at an early age not only to read but to recognize the weapons their older brothers are learning to use.

Chapter 2

MAXIM TYPE MACHINE GUN AND FEDEROV AVTOMAT

Weapons Included in This Chapter

Maxim Type Machine Guns

Design	Applicable symbol	Bore diameter	Use
English-made		7.62-mm	Ground.
Model 1905		7.62-mm	Ground.
Model 1910	PM	7.62-mm	Ground.
Aircraft	PV–1	7.62-mm	Aircraft.
Maxim-Tokarev	M-T	7.62-mm	Ground.
Maxim-Koleshnikov	M-K	7.62-mm	Ground.
Esiunin		13-mm	Ground.

Federov "Avtomat"

Designation	Bore diameter	Use
"Avtomat"	6.5-mm	Ground.

History and Background

Since late in the nineteenth century, when it was first introduced in the Czar's Army, there has never been an interval when the Maxim was not actively in use in Russian forces. It has proved to be not only the first successful automatic firing mechanism but also one of the most reliable. Its rugged construction and moderate rate of fire make it ideal for arming troops that have little mechanical aptitude; it rarely gets out of order. For generations, Russian soldiers have been trained on this mechanism, even after the introduction of newer and supposedly better types.

The early guns used were built at the Maxim Company in England, and the first step toward manufacture in Russia was the making of barrels at the Tula Arsenal. Other steps were taken gradually before complete guns were manufactured, one of which was the Model 1905 gun. Russian literature describes this gun as weighing 69 pounds dry and 78 pounds with its bronze water jacket filled. Specimens fitting this description have been noted with dates as late as 1909 on their fusee spring housing, the place where Maxim guns were marked in

Figure 2–1. Russian 7.62-mm Maxim Machine Gun Model 1905. Date of manufacture, 1909, appears on spring housing.

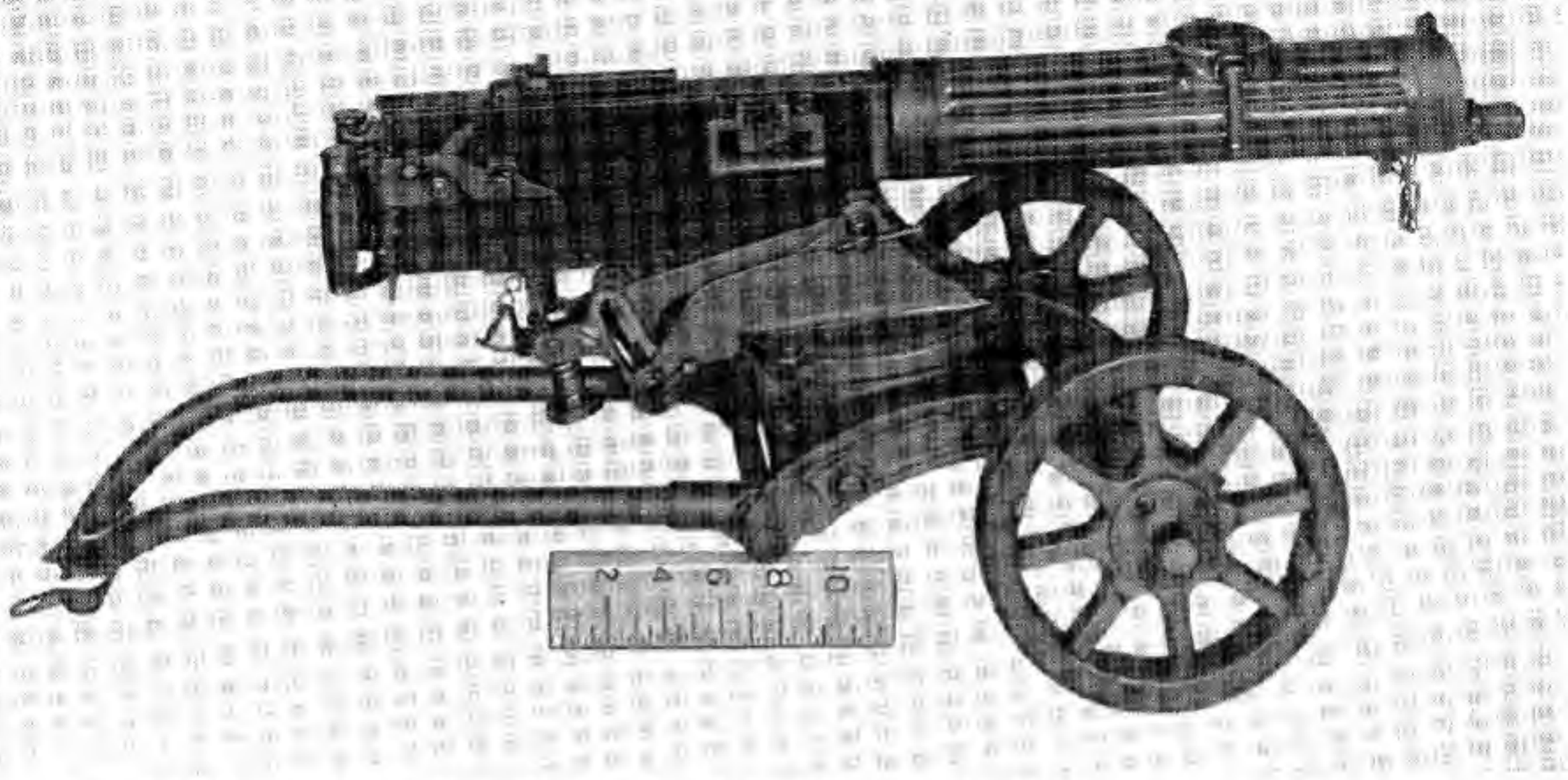


Figure 2–2. Russian 7.62-mm Maxim Machine Gun Model 1910 on Sokolov Mount. The gun is a late version.

the early days, not only in Russia but in England and Germany as well.

In a military publication dated 1912 there appears a mention of a new version, Model 1910, which differs from its predecessor in the substitution of lighter materials, thereby reducing the weight to 54 pounds with water jacket filled or 44 pounds dry. The favorite Soviet system of mounting for the Model 1910 is the Sokolof two-wheeled arrangement, which has also been used with very little deviation for over forty years.

The outstanding feature which appears in recent modifications of Model 1910 is the tractor-type radiator design used on the water jacket to expedite filling. This design was originated by the Finns and copied by the Russians. The steam and overflow pipe is very similar to the kind used on American heavy farm machinery.

During the decade preceding World War I, all the nations of Europe were interested in the advent of the light machine gun, or machine rifle. The influence of the Maxim gun was strong during this period. Most interest was concentrated on gas operated weapons of the fixed barrel type, but in Russia there was little activity in this direction. However, the reliable action of the Maxim gun which had been imported from England had been incorporated into the thinking of military men in Russia.

Soon after World War I, the Russians made a conversion from their ground Model 1910, making a fixed weapon adaptable for aircraft use. Its official designation was PV–1. This type differed from Model 1910 in that it had an improved type of booster that gave it a substantial increase in rate of fire. The barrel jacket was slotted to allow air cooling, and provision was made for the installation of a synchronizing gear. Infantry rifle cartridges were used; they were fed by means of a metallic

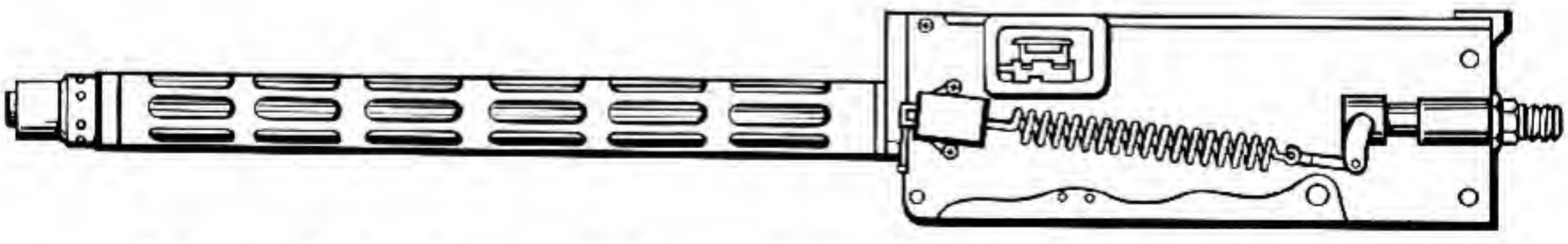


Figure 2–3. The 7.62-mm PV–1, an early Soviet aircraft machine gun, which features the Maxim action.

belt. The weight was considerably less than that of the water-cooled model; the finished product weighed only 31.7 pounds.

Shortly after the end of the war with Poland, an attempt was made to lighten the Maxim and produce it in an air-cooled version. The design of this particular weapon was under the direction of F. V. Tokarev, and it was designated M T to indicate, Maxim-Tokarev. Tokarev was doubtless inspired by both the German Parabellum and the British Vickers. The arrangement of the trigger and the shoulder stock resembles very strongly that illustrated in United States Patent No. 942167, which was granted in 1909 to Dawson and Buckham, assignors to Vickers.

The M-T represents another refinement of the Maxim principle, the main difference from the Maxim being its method of mounting. It has two

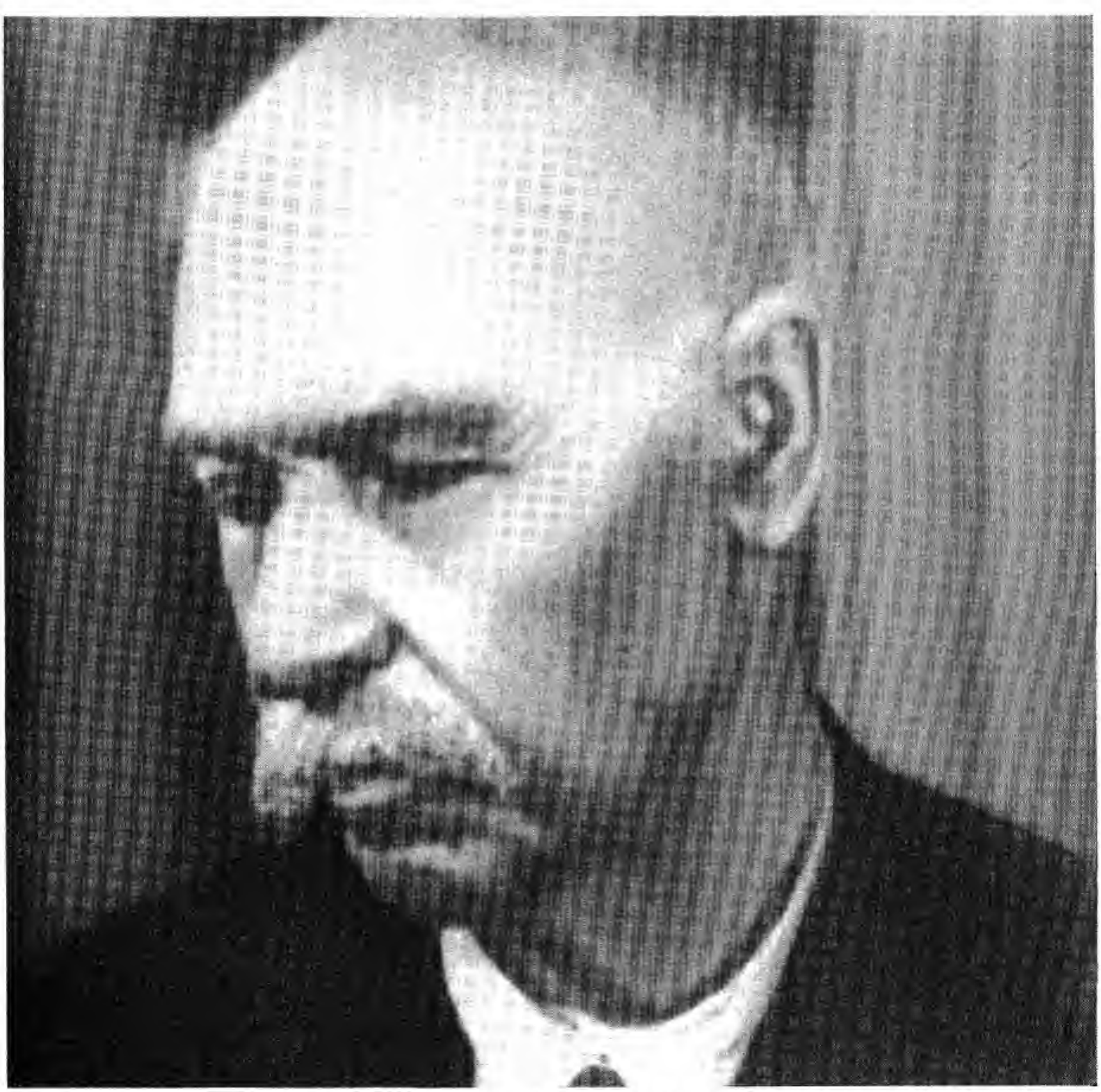


Figure 2 4. Fedor Vasil'vevich Tokarev, Soviet small arms designer and one-time officer in the Cossack Cavalry of the Czar.

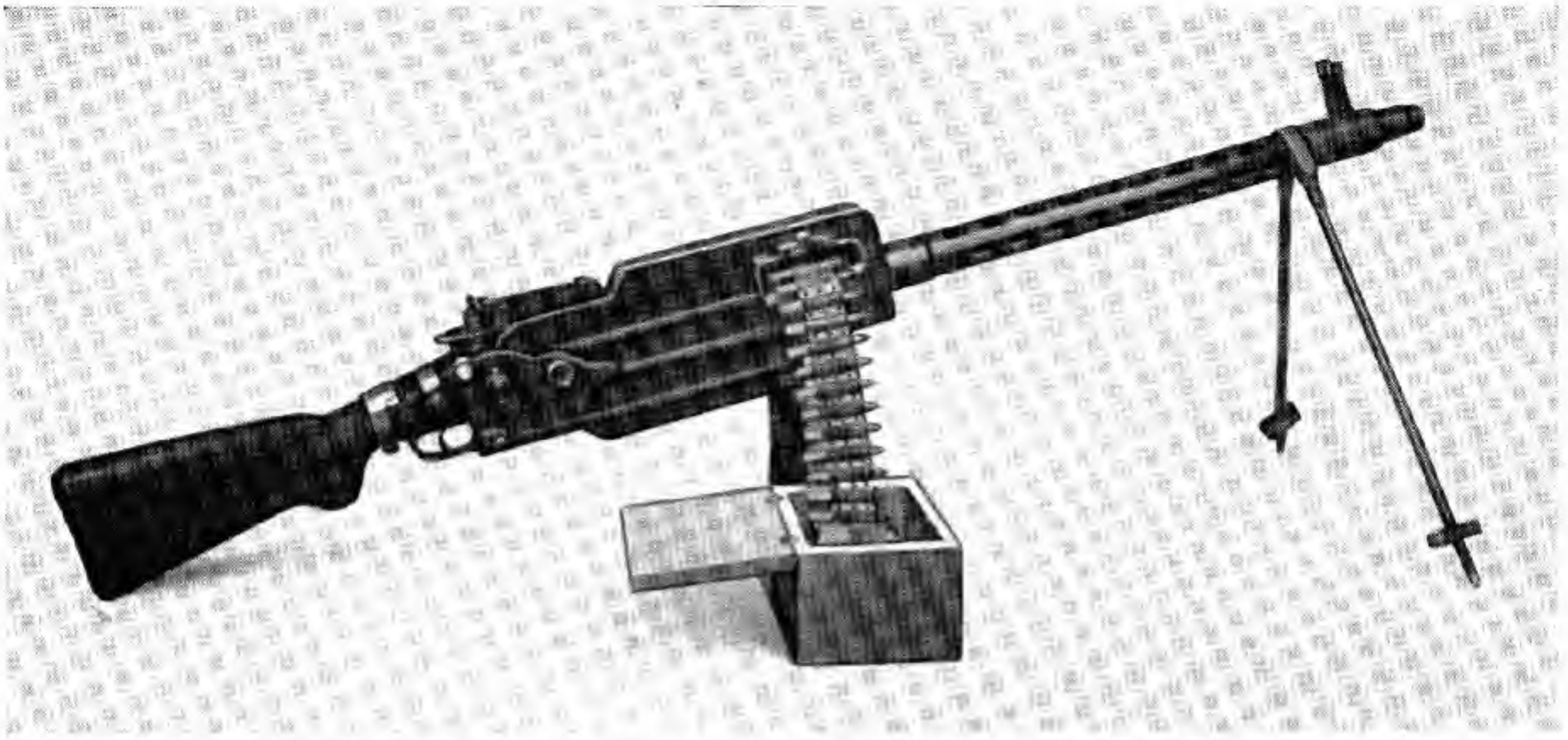


Figure 2 5. Maxim-Tokarev Machine Gun, 7.62-mm, as used in the Spanish Civil War.

metal legs in front and a wooden stock that fits against the operator's shoulder. This weapon was chambered for the standard 7.62-mm infantry rifle cartridge.

In 1928, a test of the M T was announced in the Russian press. Publicity was given to the event as part of a campaign to encourage native inventors and to promote production of automatic weapons.

A sufficient quantity of the M–T guns was made up for troop trial. The troops pointed out certain objectionable features, and when these were added to changes suggested by the factory engineers, it was discovered that the whole added up to a basic change in mechanism that had to be redesigned in its entirety. Thus, the principal advantage of the original design, the possibility of producing the action with machinery used for Model 1910, was lost. The Maxim-Tokarev appeared in battle for

Figure 2-6. Maxim-Kcleshnikov Machine Gun, 7.62-mm, as used in the Spanish Civil War.

the first time during the Spanish Civil War and later in the war between Finland and Russia.

In competition with the M T was another version of the Maxim. This gun was modified by Koleshnikov and therefore called the M–K (Maxim-Koleshnikov). It differs outwardly from the M T in the shape of the stock, but otherwise there is little difference. Koleshnikov was not successful in securing adoption of this weapon, but enough were made for trial to allow its use in the Spanish Civil War.

A designer of the same name is credited with the development, some years later of a machine gun mount for a caliber 12.7-mm gun that was then being issued to the Russian Infantry.

There was still another Russian version of the Maxim, inspired by the German T. u. F. of World War I. The Soviets accomplished the design by simply scaling up the rifle-caliber weapon until it handled a 13-mm cartridge. It is sometimes known as the Esiunin machine gun from the name of the engineer who is credited with the design.

With Russia's defeat and the Czar's overthrow, the Bolsheviks were slow in getting the country's production potentialities under control and almost nothing was done in the development of machine guns, other than trying to modify a number of Maxims left over from imperialist days to use a 13-mm cartridge. This work was first attempted in 1926 at the principal government arms manufacturing arsenal (Tulski Oruzhenic) at Tula, where E. Esiunin was design engineer.

In an official test, the prototype had a rate of fire of 300 rounds per minute. At a distance of 120 yards, it would penetrate a thickness of 30-mm of armor plate. Only a few heavy machine guns so modified were actually made; in fact, records show that only eight were delivered and these were distributed among the instructional departments of the Moscow garrison's military educational establish-

Figure 2-7. The Maxim Model 1910 in World War II. Personnel are in Naval uniforms of this period.

ments. Subsequently, all work stopped on this heavy type Maxim, and production activity centered on the standard rifle caliber weapon.

Federov "Avtomat." One noteworthy departure from the Maxim design involved two names now well known in this field of endeavor. In the early nineteen hundreds, Captain of the Guards Vladimir Grigorevich Federov worked on a design for a fully automatic shoulder rifle. In the course of his work, at the Proving Ground at Orenienbaum, he met a young soldier who had been a machinist at the Tula factory, Vasiliy A. Degtyarev. The meeting was the beginning of a long association, which lasted until Degtyarev died.

In 1908, these two men were working at Sestorets Fire Arms Plant; at the same time, Cossack F. V. Tokarev was working there on another automatic rifle design. Other systems were under development by Roschepei, Schukinn, and Frolov.

In 1910 and 1911, trials were conducted on several automatic rifle systems. The Roschepei system showed considerable promise; however, in 1912 an order was given to produce 150 of the Federov design. Work proceeded slowly, and the outbreak of World War I stopped the program.

Between 1911 and 1914 Federov was working on a second model of his weapon; however, before conclusive tests were made, he was forced to drop this line of endeavor to go abroad on a mission to buy rifles in Japan and Europe. The Japanese rifles which were purchased probably had some influence on the selection of the Japanese cartridge for the second model of Federov's gun, which was produced in a small lot at the Sestorets Plant in 1916.

The "Avtomat" saw service in the Russian Civil War, but it was not a success. About 3,000 in all were produced, making it the first Russian designed automatic arm to be produced in any quantity.

SECTION 1. MAXIM TYPE MACHINE GUN

General Data on Maxim Model 1910

Caliber: 7.62-mm.
Rate of fire: 300–500 rounds/minute.
Muzzle velocity: 2,620 feet/seconds with heavy pointed ball (yellow tip bullet).
Gun length: 43.4 inches.
Gun weight: 39 pounds without mount and with water jacket empty; 145 pounds on mount with full jacket.
System of operation: Short recoil with muzzle booster assist.
System of locking: Toggle joint.
System of feeding: Belt, fabric.
Method of charging: Manual crank arrangement.
Method of cooling: Water.
Rate increaser: Muzzle booster over barrel end.
Barrel weight: 6 pounds 8 ounces.
Barrel length: 28.4 inches.
Barrel removal: This is not a quick change barrel.
Bore:
  Number of grooves: 4.
  Groove depth: 0.14–0.21 inch.
  Groove width: 0.375–0.390 inch.
Pitch: 5° 41′.
  Direction of twist: Right hand.
  Form of twist: Standard constant.
Method of headspace: Adjusting toggle locking nut.
Location of feed operation: Right side.
Location of ejection opening: Bottom of receiver.

Description of the Maxim Action

This gun derives its operating energy from short recoil with an assist from a muzzle booster. After recoiling ¾ inch, the bolt is unlocked; then the recoiling forces and remaining high residual pressure in the chamber accelerate the bolt assembly to the rear. The recoil movement causes a cam lever action that moves the entire feed block slide to the right. The feed pawls move over to engage the incoming round in the belt, which is being held in position by the bottom belt-holding pawl, and at the same time compress the barrel return spring.

Counter-recoil movement of the barrel and its extension returns the feed block slide to the left, indexing the incoming round into position against the cartridge stops for engagement by the sliding T-slot. The backward movement of the bolt assembly is stopped by tension applied by the fusee spring. Charging is accomplished manually with a crank arrangement located on the right side of the piece. Although the weapon is relatively simple in con-

Figure 2-8. Soviet-Asiatic Troops in World War II with the Maxim Model 1910 on an AA Mount with horse-drawn transport.

struction, mass production has remained a difficult problem through the years it has been in use.

Cycle of Operation

To fire any of the Maxim type guns, the gunner inserts the loaded ammunition belt into the upper right side of the receiver to the position where the cartridge comes to rest on the stop. He then rotates the cocking handle all the way forward and releases it. He raises the safety catch, which permits the thumb piece to be pushed forward actuating the trigger bar and sear; then the firing pin is released. As the powder charge is ignited and pressure is built up to its peak, the barrel and bolt are securely locked. They remain locked as long as the bullet is in the bore.

After recoiling ¾ inch, the bolt is unlocked by the crank engaging the unlocking cam, freeing the bolt. The recoiling forces aided by residual pressure in the bore accelerate the bolt assembly to the rear and further rotate the crank. This motion winds the actuating chain, loading the extension type driving spring while the recoiling mechanism completes its rearward stroke.

At the first movement of recoil after unlocking, the sliding bolt face (T-slot) begins simultaneous extraction of the empty case from the chamber and withdrawal of the loaded round from the belt. Continued rearward movement engages cams in the receiver to force the sliding bolt face downward and bring the loaded round into alignment with the chamber and the empty case in position for ejection through the bottom of the receiver.

The cartridge to be chambered is held in place by a latch arrangement located in the face of the T-slot. During recoil, a cam lever action moves the entire feed block slide to the right. The top feed pawls move over to engage the incoming round in the belt, being held in position by the bottom belt-holding pawl, at the same time compressing the barrel return spring.

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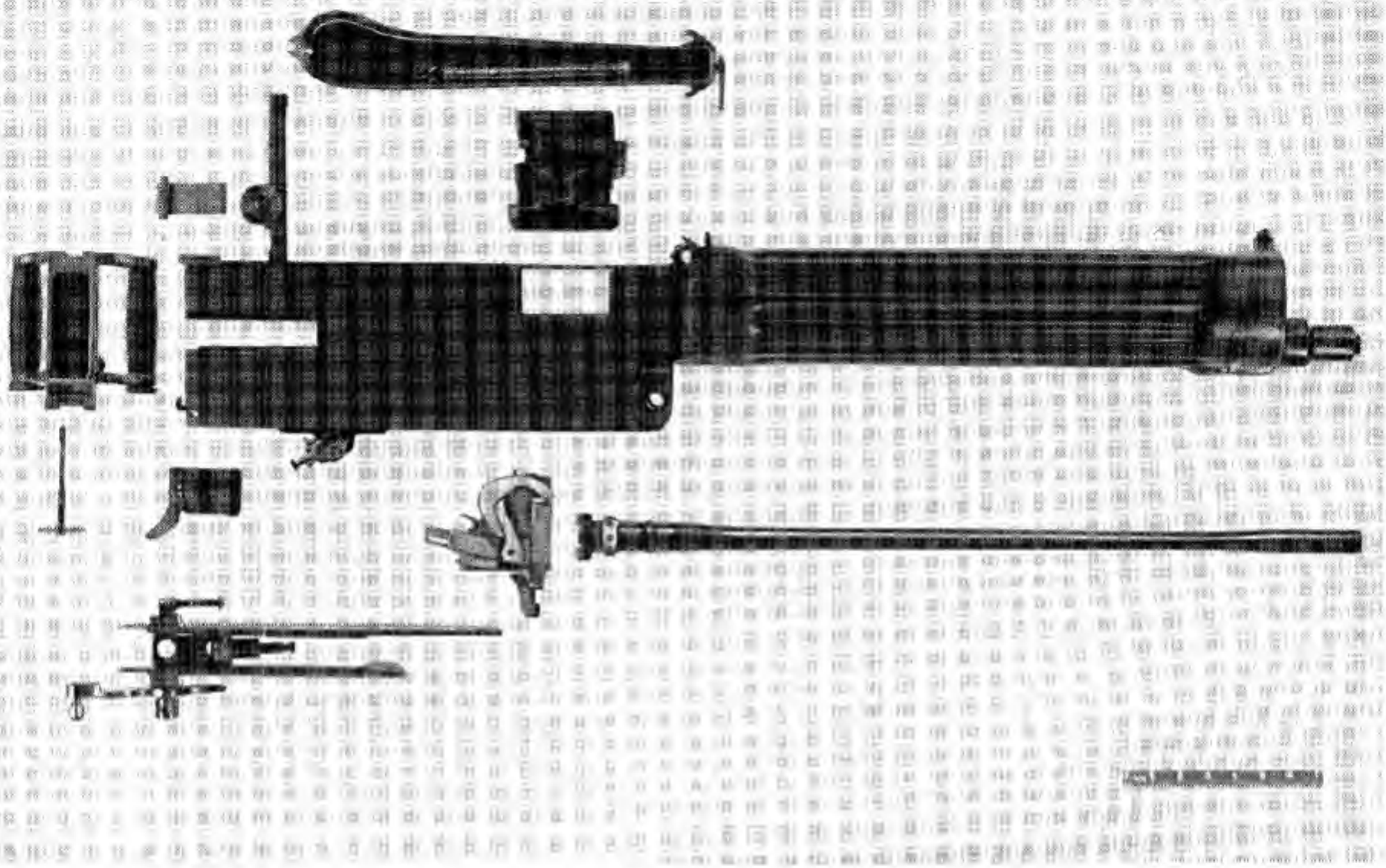

Figure 2 9. Russian Maxim Machine Gun Model 1910, field stripped.

After completion of the full recoil stroke, the forward action of the barrel and barrel extension returns the feed block slide to the left, indexing the next round in the ammunition belt against the cartridge stops for engagement by the sliding T-slot.

After the complete force of recoil has expended itself, the extended spring starts the movement of counter-recoil. As the bolt moves forward, the cartridge to be chambered is positioned. With this being accomplished, the T-slot rises and "wipes" itself clear of the spent case and continues upward to slip over the incoming round in the belt.

When the bolt has reached its extreme point in forward travel, the toggle joint is forced slightly below the horizontal by the connecting rod. At this securely locked position, the sear is depressed and disengaged from the firing pin, removing the safety feature, allowing continued pressure on the trigger piece to cause a continuation of automatic fire.

Disassembly by Groups

To Strip the Gun:

1. Take out joint pins, crosshead and elevating and remove the gun from its mounts.

2. Drive out fixed pin of joint pin cover, remove collar and joint pin, press cover lock forward, and take off cover.

3. Remove feed block and lock. Take off fusee spring and cover.

4. Drive out taper pin from rear cross-piece; take hold of the handle with the left hand and strike the top edges of the breech casing alternately with a wooden mallet. The rear cross-piece will then lift out. Drive out taper pin from check lever and remove collar and check lever. Unscrew and remove packing gland and packing. Remove slides right and left. With the handle of the crank upward, draw out the barrel.

5. Remove the trigger spring and lift out the trigger bar. Place the barrel casing on a bench,

Figure 2-10. Soviet horse-drawn machine gun unit in World War II, equipped with the Maxim Model 1910 Gun.

support the breech casing with the left hand immediately in front of the elevating bracket; then strike the top edges of the breech casing alternately with a wooden mallet, near the barrel casing, taking care not to strike the metal. The breech casing will then come away.

Assembly by Groups

To assemble the gun, reverse the foregoing procedure.

Detailed Disassembly and Assembly

To Strip the Feed Block. Drive out spring fixing pin. Drive out bottom lever, and remove top lever and slide. Unscrew and remove fixing screws of feed block springs and remove the latter. Drive out axis pins of bottom pawls, and remove pawls. Drive out taper pin from roller axis pin and remove collar pin. Remove stop screw. Remove top pawls from slide by pressing them outwards.

NOTE. The slide springs are riveted to the slide.

To Assemble the Feed Block. Reverse the procedures for stripping the feed block.

To strip the Lock. See that the lock spring is released. Remove the keeper pin of lock-spring pin and drive out the latter. Remove keeper bracket, extractor levers, and lock spring. Remove keeper pin of trigger pin and drive out the latter to remove trigger. Drive out tumbler pin; remove tumbler. Drive out scar pin; remove scar and firing pin. Remove keeper pin of extractor stop pin and drive out this piece. Remove extractor stop, extractor, and gib spring cover. Take out gib spring and gib. The extractor pin is riveted to the extractor.

NOTE. Keeper pins may be removed by straightening and drawing out with pliers.

To Mount the Lock. Reverse the procedures for stripping the lock.

NOTE. When the tumbler pin is in its place, clinch it with a few blows of a small hammer and clean it off if necessary with a file.

SECTION 2. FEDEROV AVTOMAT

General Data

Caliber: 6.5-mm.
Rate of fire: 350-400 rounds/minute.
Muzzle velocity: 2,145 feet/second.
Gun length, without bayonet: 39 inches.
Weight:
  Gun without bayonet: 9.7 pounds.
  Magazine, empty: 0.88 pounds.
  Magazine, loaded: 1.76 pounds.
System of operation: Short recoil.
System of locking: Pivot lock.
System of feeding: Box magazine, capacity 25 rounds.
Method or charging: Manual.

Description of the Weapon

The Federov "Avtomat" is an intermediate weapon of a more powerful type than the submachine gun but not equalling the firepower of the light machine gun. Although it fires the old Japanese infantry cartridge it is handicapped by the lightness of its barrel, which overheats rapidly in automatic fire. The best known version is the Model 1916, which was reported in use in the Spanish Civil War. The use of the term "Avtomat" to describe this class of weapon is somewhat similar to the British usage of "automatic" to describe the weapons known in the United States as machine rifles and light machine guns but the terms are not interchangeable.

The gun is operated by short recoil, and locking is accomplished by a pair of pivot locks on the rear of the barrel. The design is very complicated and shows traces of influence of the Mauser pistol, which was sold commercially in Russia long before World War I. A detachable box magazine is used, the capacity of which is 25 rounds, and the cartridges are staggered. A holding-open device is provided to facilitate reloading through the receiver without removing the magazine. The firing mechanism is of the hammer type. The trigger arrangement allows single shots or full-automatic fire at will, by setting the change lever.

Cycle of Operation

When a shot is fired, barrel and bolt recoil together a short distance. During this motion, the barrel spring is compressed. The locks are then cammed down and the bolt is free from the barrel. At this time a projection on the accelerator strikes a bridge in the receiver and, pivoting on its axis, imparts a greater velocity to the bolt, thus separating it from the barrel. Then the rearward movement of the barrel is stopped by a projection in the receiver, and it is held rearward by the barrel stop. Meantime the hammer has been cocked, and extraction and ejection have taken place.

Under action of the return spring, the bolt moves forward, striking the accelerator and turning it. This disengages the barrel stop from its coupling in the receiver. Barrel and bolt now move forward, and locking takes place when the pivots are cammed up by the projections in the receiver. The weapon is now ready to fire again.

Figure 2-11. The Federov "Avtomat".

Chapter 3

DEGTYAREV AND GORYUNOV MACHINE GUNS

Weapons Included in This Chapter

Degtyarev Machine Guns

Design	Applicable symbol	Bore diameter	Use
Degtyarev Infantry.	DP	7.62-mm	Ground.
Degtyarev Aircraft..	DA	7.62-mm	Aircraft.
Degtyarev Tank....	DT	7.62-mm	Tank.
Degtyarev Infantry Modified.	DPM	7.62-mm	Ground.
Degtyarev Tank Modified.	DTM	7.62-mm	Tank.
Degtyarev 1946 Infantry.	"Company"	7.62-mm	Ground.
Degtyarev Medium.	DS	7.62-mm	Ground.
Degtyarev Heavy...	DK	12.7-mm	AA.
Degtyarev-Shpagin Heavy.	DShK	12.7-mm	AA.

Goryunov Machine Gun

Design	Applicable symbol	Bore diameter	Use
Stankovaya Goryunov 1943.	SG–43	7.62-mm	Ground.

History and Background

In the early nineteen twenties, Vasiliy Alexeyevich Degtyarev, the noted small arms inventor, began to coordinate the design of a machine gun intended for various uses and designated to identify the designer (D) and the use (P, A, T, etc.). The symbols used on Soviet machine guns and aircraft cannon are explained in chapter 10. An illustration of markings on a Degtyarev DTM infantry machine gun appears on page 44. The DShK combined the design talent of both Degtyarev and Shpagin. Obituaries of both designers have appeared in official Soviet newspapers, indicating that they died in good favor.

Degtyarev worked for four years on the first model of the DP (Degtyarev Infantry) before it was tested in 1926. The DA (Degtyarev Aircraft) appeared in 1928. The DT (Degtyarev Tank) made its initial appearance in 1929.

By 1933, the DP was being produced in quantity. The three models just mentioned were originally manufactured at Tula Arsenal. Later, production of the DA was supplemented elsewhere.

The early version of the DP was known outside the U. S. S. R. by the early thirties. It saw service in the Spanish Civil War, where it proved the Russians had one of the most reliable and simply constructed light machine guns known at that time.

The DK (Degtyarev Heavy) appeared about 1934 and was a predecessor of the DShK, which ap-

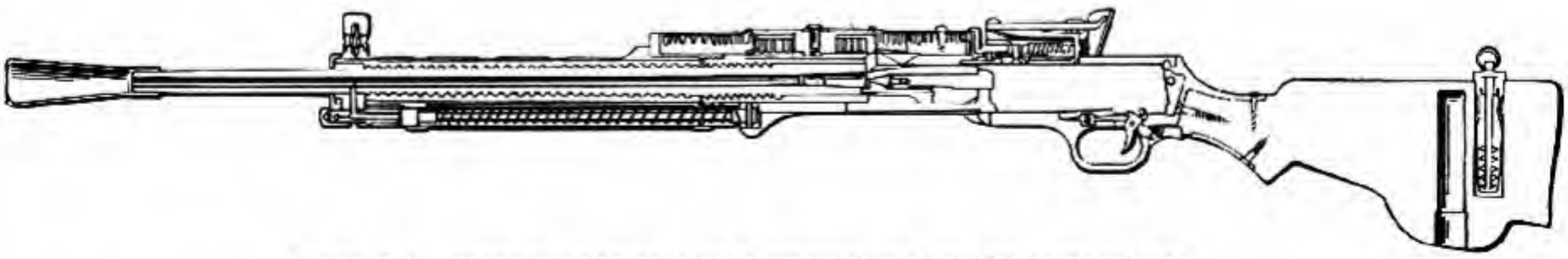

Figure 3–1. Degtyarev 7.62-mm Light Machine Gun Model DP, sectional view.

Figure 3-2. Degtyarev Tank Machine Gun in antiaircraft firing position.

Figure 3 3. Hero of Socialist Labor, Vasiliy Alexeyevich Degtyarev (deceased), one-time Major-General of the Artillery Engineering Service.

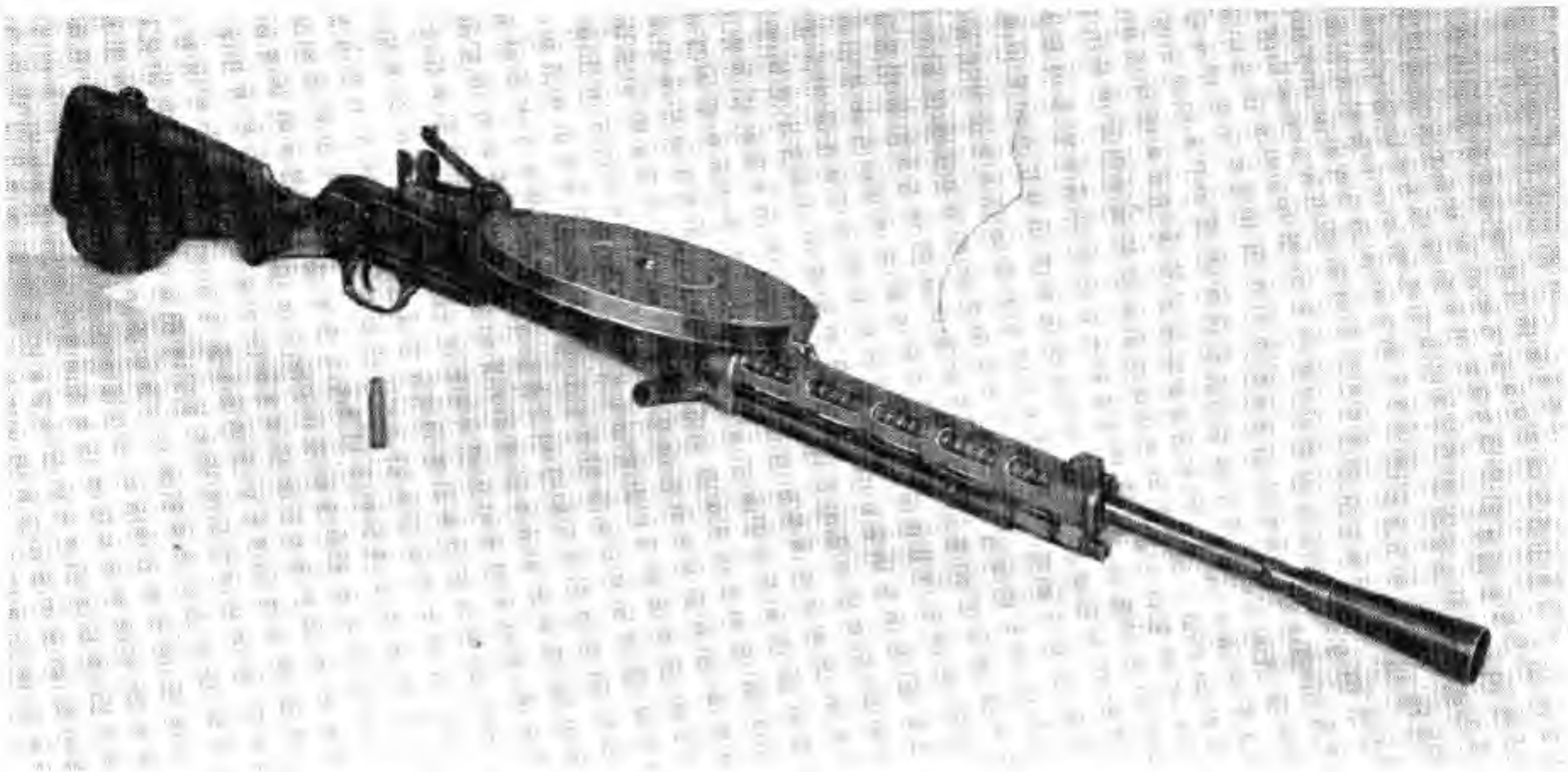

Figure 3 4. The 7.62-mm Soviet Light Machine Gun commonly called the DP, which identifies it in the Russian Service as "Degtyarev Infantry."

peared in 1938. The DK had very limited use.

The DS (Degtyarev Medium) was the white hope of the Soviets in their campaign to replace the Maxim Model 1910. This Maxim model had been in use and under manufacture in Russia for over four decades. Many designs reputed to be superior to the Maxim were on the drafting boards. Of these possibilities, the DS was chosen for careful development and production. However, features of the DS including its "deluxe" exterior finish made it too difficult to manufacture. True to their temperament, the Soviets began to ignore the DS in their literature. Few specimens have been found.

The DTM (Degtyarev Tank Modified) is a modification of the DT. It appeared at the close of World War II.

The "Company" (Degtyarev 1946 Infantry) is the latest model used by the infantry.

SG–43. The Soviet's need for a new machine gun to replace the Maxim is well known. After the DS (Degtyarev Medium) was abandoned, attention was centered on a weapon with an entirely different appearance. Its first official designation was Stankovaya Goryunov 1943; this was soon abbreviated to SG–43.

This automatic firing mechanism was engineered by the gifted designer Peter Maximovitch Goryunov. The designer barely lived to see the results of his labors; he died at the age of 41, within a few months after his gun had been officially accepted by the military authorities in charge of procurement of automatic arms. His brother M. M. Goryunov and an engineer named Voronkov, who assisted him on the original model, were given official orders to carry on development work for the purpose of improving the existing model.

SECTION 1. DEGTYAREV MACHINE GUNS

General Data

The following models have characteristics which are the same or similar to the DP except as noted in footnotes to the following table.

DA (Degtyarev Aircraft).
DT (Degtyarev Tank).
DPM (Degtyarev Infantry Modified).
DTM (Degtyarev Tank Modified).
"Company" (Degtyarev 1946 Infantry).

Figure 3-5. Hero of Socialist Labor George S. Shpagin (deceased), co-designer with Degtarev of the DShK.

Table of Characteristics of DP (Degtyarev Infantry) Production Version

Caliber: 7.62-mm.
Rate of fire:
  Cyclic: 500–600 rounds/minute.
  Effective: 80 rounds/minute.[1]
Muzzle velocity: 2,770 feet/second.
Effective range: 880 yards.
Gun length: 50.5 inches with flash hider.[2]
Gun weight:
  With bipod: 20 pounds.
  Without bipod: 15 pounds.
System of operation: Gas operated.
System of locking: Swinging locks.
System of feeding: Flat spring loaded drum holding 47 rounds.[3]
Method of charging: Manual.
Method of cooling: Air.
Barrel weight: 4¾ pounds.
Barrel length: 23⅞ inches.
Barrel removal: Quick change.
Chamber pressure: 44,000 p. s. i.
Bore:
  Number of grooves: 4.
  Groove depth: 0.015 inch.
  Direction of twist: Right hand.
  Form of twist: Standard.
Method of headspace: Key that locks barrel gives minimum clearance when securely in place.
Location of feed opening: Top of receiver.
Location of ejection opening: Bottom of receiver.
Type of safety: Grip safety.[4]

Figure 3–6. The 7.62-mm DS in action. A Soviet propaganda photo of World War II: actually, an insignificant number of this model were made.

NOTE 1. The tank versions are claimed to have an effective rate of fire of 125 rd/min. The "Company" 1946 model is claimed to have an effective rate of 80 rd/min with disk magazine and an effective rate of 250 rd/min with the belt feed.

NOTE 2. Gun with adjustable stock is 39.8 inches long without flash hider when the stock is retracted.

NOTE 3. The tank versions have a 60-round disk magazine. The "Company" 1946 model can use the 47-round disk magazine or 50-round link belts. Belts may be linked together for greater periods of sustained firing. The "Company" may be belt-fed also. See Note 1.

NOTE 4. All other models have safety lever.

General Data on DS (Degtyarev Medium)

Caliber: 7.62-mm.
Cyclic rate of fire:
  Normal: 500–600 rounds/minute.
  Fast: 1,000–1,200 rounds/minute.
Type of fire: Full automatic only.
Muzzle velocity: 2,650 feet/second.
Chamber pressure: 44,000 psi.
Gun length, overall: 46 inches.
Gun weight:
  Gun only: 26.4 pounds.
  With tripod and shield: 72 pounds.
System of operation: Gas.
System of locking: Swinging locks.
System of feeding: 250-round canvas belt or 50-round metallic link belt.
Method of charging: Manual.
Method of cooling: Air.
Rate control: Buffer adjustment.
Barrel length: 28.4 inches.
Barrel removal: Not quick change.

General Data on DK (Degtyarev Heavy) and DShK (Degtyarev-Shpagin Heavy)

Caliber: 12.7-mm.
Rate of fire:
  Cyclic: 550–600 rounds/minute.
  Usable: 125 rounds/minute.
Muzzle velocity: 2,763 feet/second.
Gun length: 62.3 inches.
Gun weight: 73.48 pounds.
System of operation: Gas.
System of locking: Swinging locks.
System of feeding: Metallic link belt.
Weight of 50 rounds in belt: 19.8 pounds.
Method of charging: Manual.
Method of cooling: Air.
Chamber pressure: 52,000 psi.
Barrel length: 39.37 inches.
Barrel removal: Not quick change.
Location of feed opening: Top.
Location of ejection opening: Bottom.
Maximum effective range: 3,792 yards.

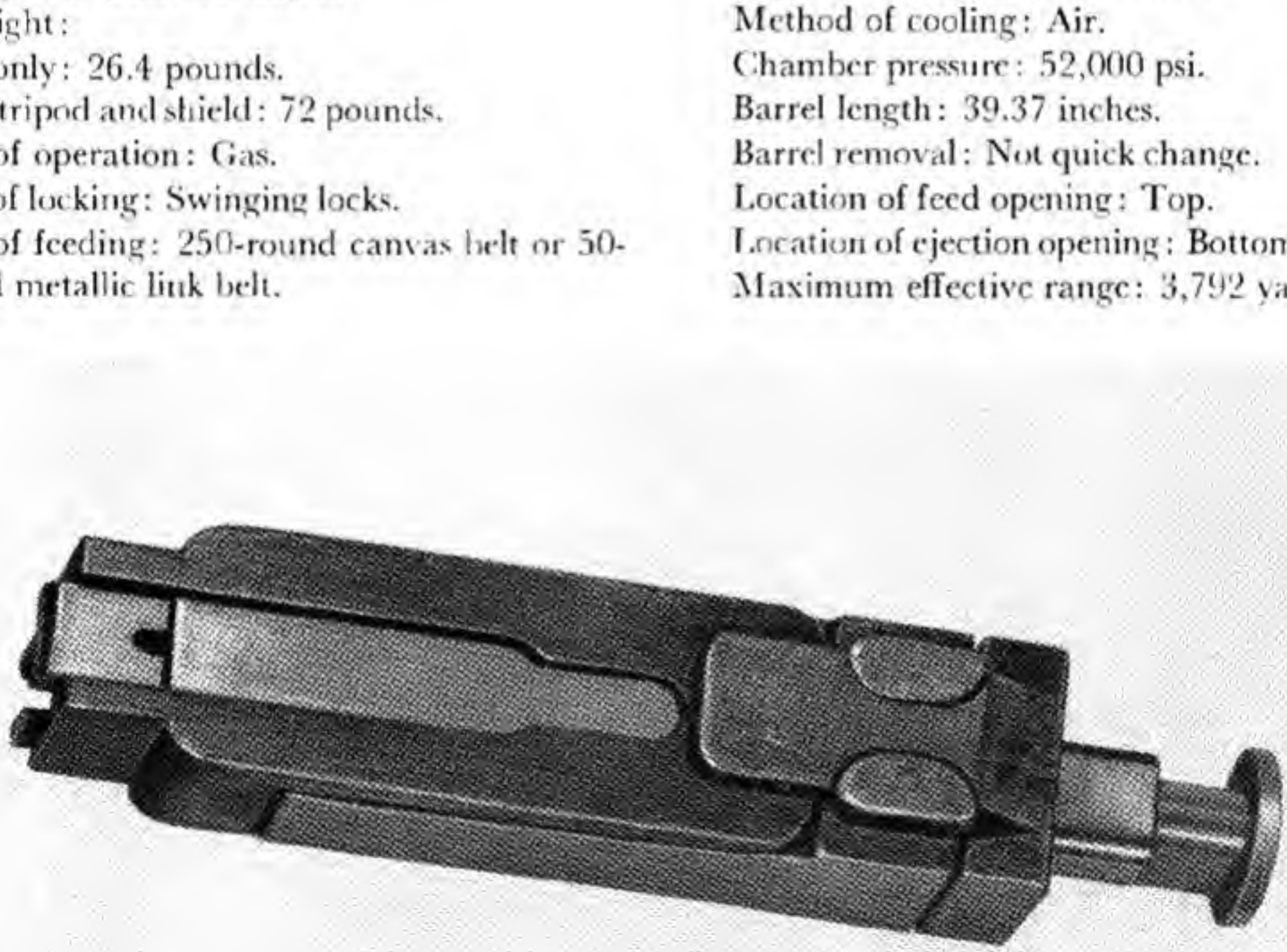

Figure 3 7. Symmetrical locks, pivoting in the bolt body: this method is employed in all Degtylarev-designed machine guns.

Description of the Weapon

DP (Degtyarev Infantry). This is a light machine gun and is the basic type in the group of machine guns designed by Degtyarev. The other models are variations or improvements of the basic design.

This gun is notorious for its unfinished appearance; the production pattern, involving a preponderance of semiskilled labor, did not allow for refinement of manufacture.

The locking system is composed of two swinging pieces that securely hold barrel, receiver, and bolt together while the bullet is in the bore. The system of locking is an adaptation of one of Paul Mauser's early actions, which he used on an experimental semiautomatic rifle, and it is also very similar to the Swedish Kjellman-Friberg locking system, used on the machine gun of that name. However, Degtyarev reversed the principle; instead of the firing pin advancing and thrusting the locking levers out at the front of the bolt, it cams the base of two small swinging locks out to butt against the locking plates when pressure is brought to bear on the face of the bolt. Where Mauser and Friberg employed recoil to unlock, Degtyarev used gas pressure to drive the piston rearward together with the firing pin, which held the two wing-shaped locks into engagement. After the firing pin has been withdrawn the angles on the faces of the breech locks and their locking seats are such that the locks cam themselves out of contact and recoil with the bolt while holding the firing pin to the rear.

The drum feed is very similar in construction and operation to the one used on the Vickers-Berthier aircraft machine gun, differing from the Lewis-type drum in that the inner part of the drum rotates while the outer part remains stationary.

There is a marking on the pancake-style drum to indicate that it holds 47 instead of 49 cartridges. This was done because field use proved performance more reliable when the lesser number of rounds were loaded.

On all guns after the prototype, a cone-shaped flash hider was incorporated in the design. The use of the flash hider necessitated threading the barrel to receive it.

On some guns, the cooling ridges on the barrel were omitted to facilitate production. Both types of barrels may be encountered.

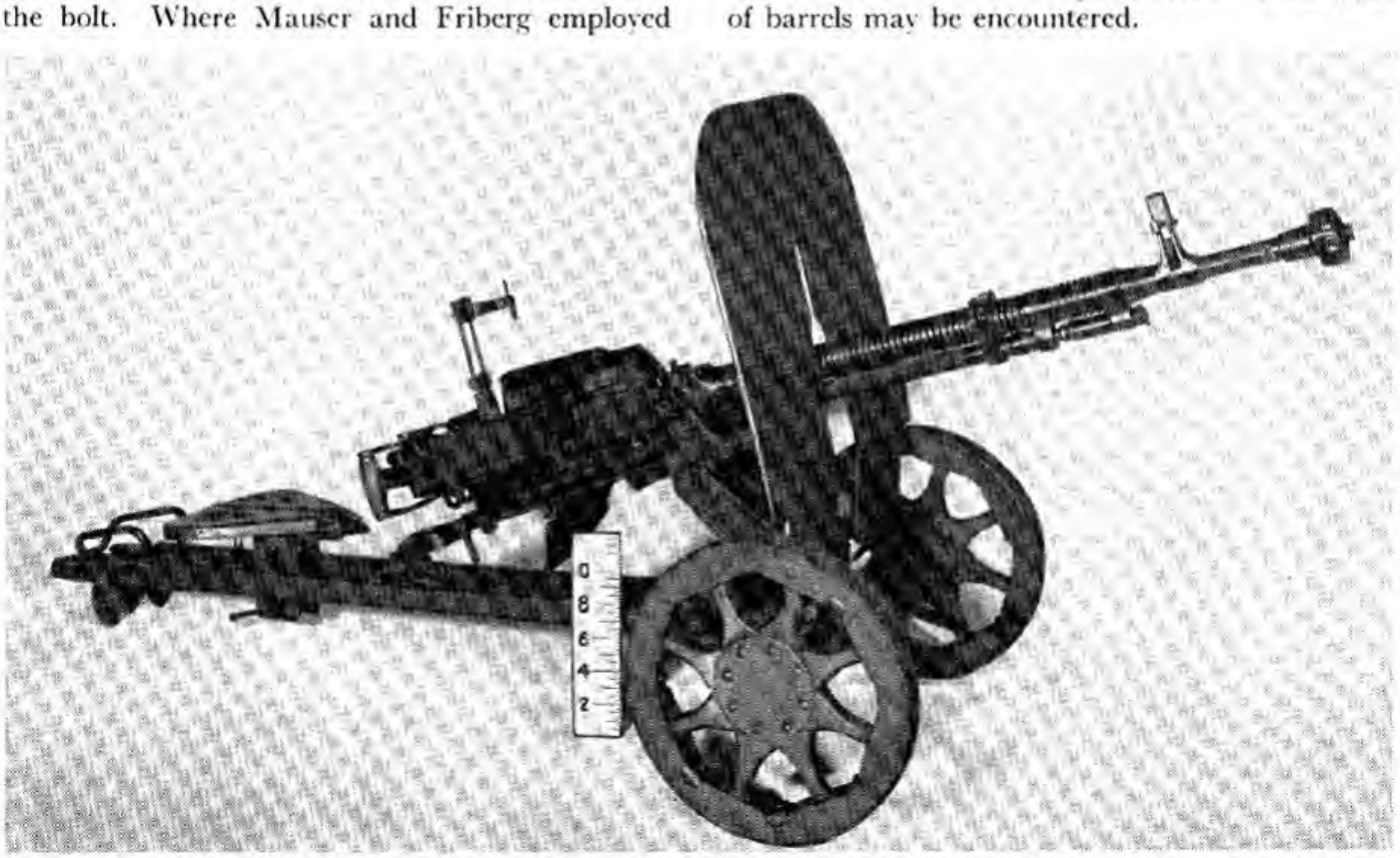

Figure 3–8. The 12.7-mm Heavy Degtyarev Machine Gun which was standardized in 1938 as the DShK. The specimen shown was manufactured in 1945.

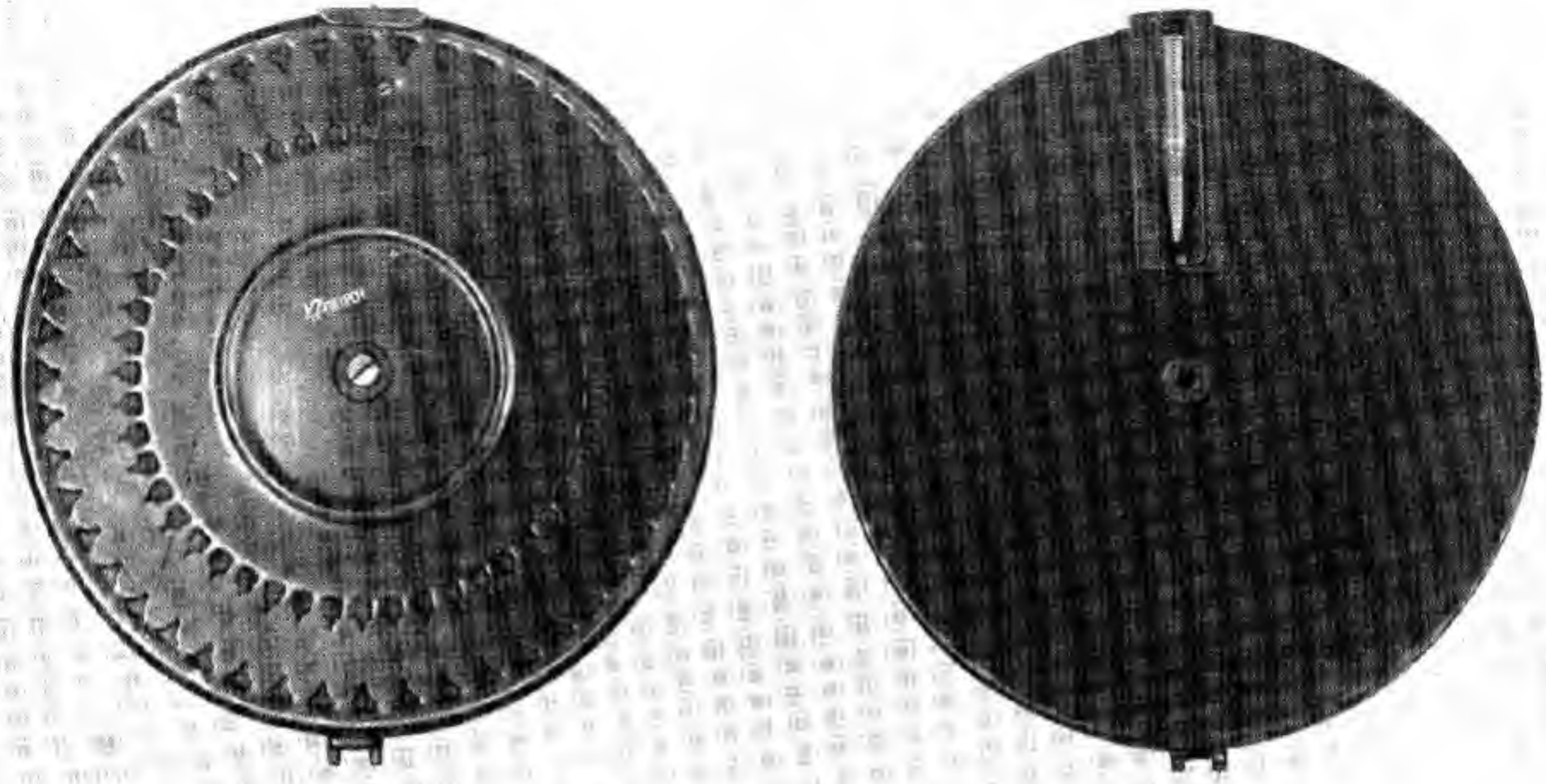

Figure 3-9. The drum magazine used with the DP gun. The marking specifies 47 rounds as the drum capacity.

The original version of the DP was chambered for the Russian infantry 7.62-mm rifle cartridge and weighed 15 pounds without bipod or the 49-shot flat drum-type magazine. It was gas operated and air cooled, with a non-recoiling barrel. The principal parts were the receiver, barrel, gas cylinder and piston, bolt and lock, firing pin, and driving spring.

The magazine feed of this original DP model caused considerable difficulty and changes were made in the second version to correct this weakness.

The original version of the DP did not provide for quick barrel change. After 400 to 500 shots had been fired in rapid succession, the barrel became so hot that aiming at the target was impossible because of heat waves. Restrictions were drawn up for limiting burst firing to a small number of rounds until the weapon could be modified. The improved version has a quick-change barrel. The number of parts was slightly reduced.

Barrel change is accomplished on this model by the following steps: After unscrewing the flash hider and the gas cylinder nut, the cylinder was then slid to the rear of the gas cylinder body. The two securing pins were drifted out and the barrel with its interrupted threads was then separated from the receiver by use of a tool on the rear of the flash hider. While this method was more complicated than that employed on most other machine guns of similar design, it could be done in a short time by the average operator.

In the original model, the return spring for the recoiling parts was housed in the cylinder under the barrel; this caused the spring to heat. This condition was corrected in the production version of the DP by means of ventilation slots in the barrel jacket, which permitted better circulation of air. A gas regulator on both versions gave ten shots a second at the maximum opening.

A novel squeeze type of safety was located at the rear of the trigger guard and was so designed that when the operator places his hand around the upper part of the shoulder stock, it depresses the safety.

The DP served the Soviets well during World War II, and since the end of the war it has made an ideal weapon for arming the satellite forces. Because of the difficulty of reloading the magazine, particularly in cold weather, a loading device officially called the PSM has been added. The PSM allows the soldier to refill the magazines from any position: sitting, standing, or lying down.

Figure 3-10. Degtyarev 7.62-mm Aircraft Machine Gun DA. Although obsolete for aircraft use, these guns are now employed by Russia's satellites in less important roles such as fixed antiaircraft defense.

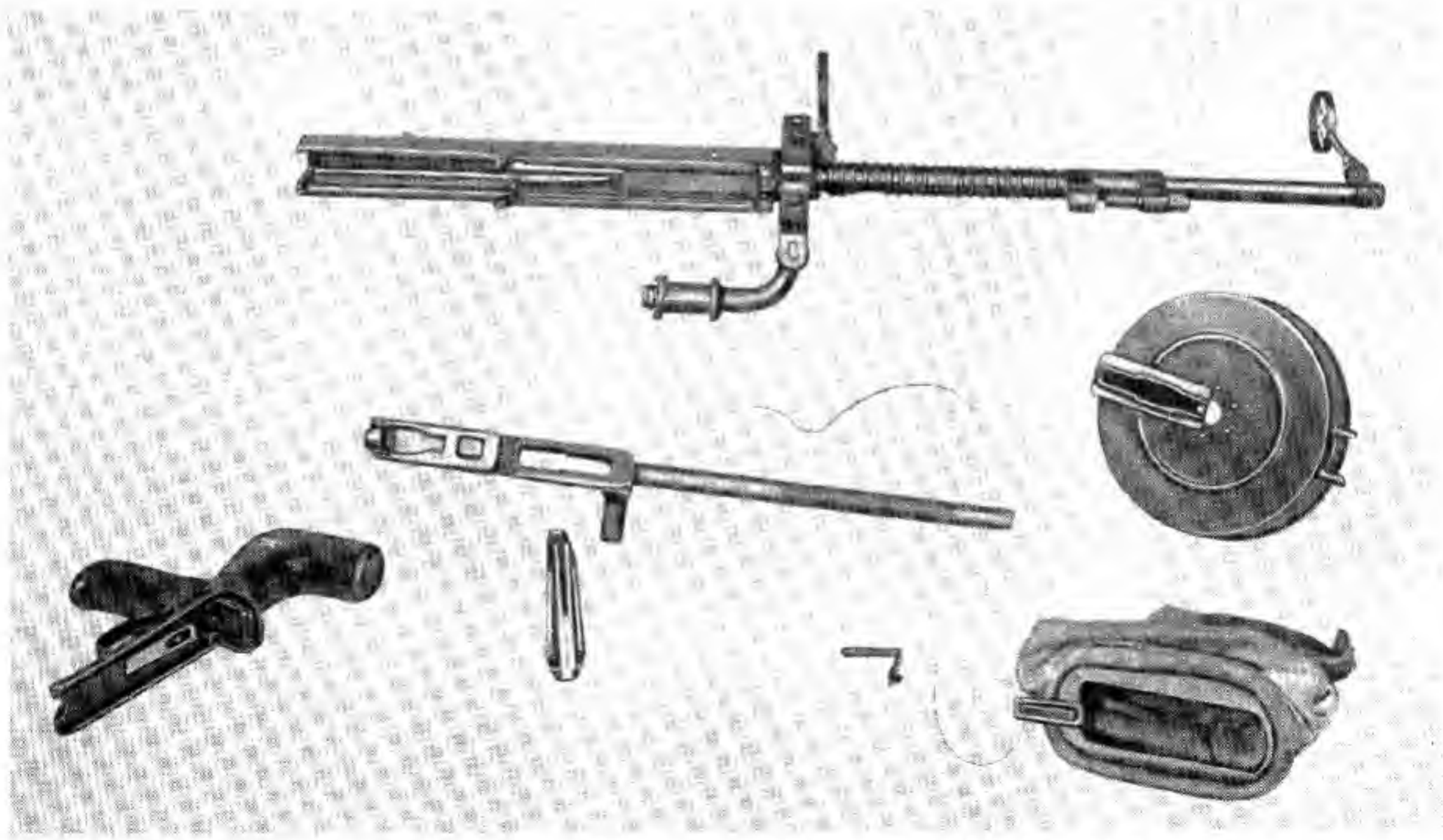

Figure 3-11. Degtyarev 7.62-mm Aircraft Machine Gun DA, field stripped.

While the construction of the weapon is very simple, it is believed by many that its exaggerated simplicity impairs to a great degree its function in the field. One of the most serious deficiencies is the existence of large flat bearing surfaces in the mating operating parts, which could interfere with both aim and cycle of operation.

The most prevalent malfunction to take place during combat has been listed by the Russians as insufficient recoil, due to the following reasons: (*a*) penetration of dirt into the mechanism, (*b*) too-thick lubricant on the mechanism, especially in winter, (*c*) choking of the gas port regulator by carbon or dirt, and (*d*) escape of gas between the gas regulator and the piston, brought about by a defect in the manufacture of these pieces.

On the counter-recoil stroke, the most common stoppages have been listed as (*a*) dirt getting into the action, and (*b*) too-thick oil on the recoiling parts.

The magazine rotates through the action of a wound spring. This feature is often found to be to blame for failures especially when the spring becomes too weak to turn the disk the one space necessary to index the incoming round.

The gas piston is very similar to all other automatic firing mechanisms with such an action. One end is formed into a piston and enclosed with the driving spring in a tubular housing beneath the barrel.

When trigger pressure is removed at the end of a long burst, the bolt remains to the rear in a cocked position, thus preventing a round being left in an overheated chamber.

DA (Degtyarev Aircraft). Through desperation more than intent, the Russians pressed the Degtyarev ground gun into service in the air and named it the DA. Its usefulness was limited; and just as soon as an adequate weapon was made to replace it, the DA was abandoned. The rate of fire was far below what was considered to be the minimum for aircraft weapons. While the ground gun served the troops well and was well received by them, the DA did not

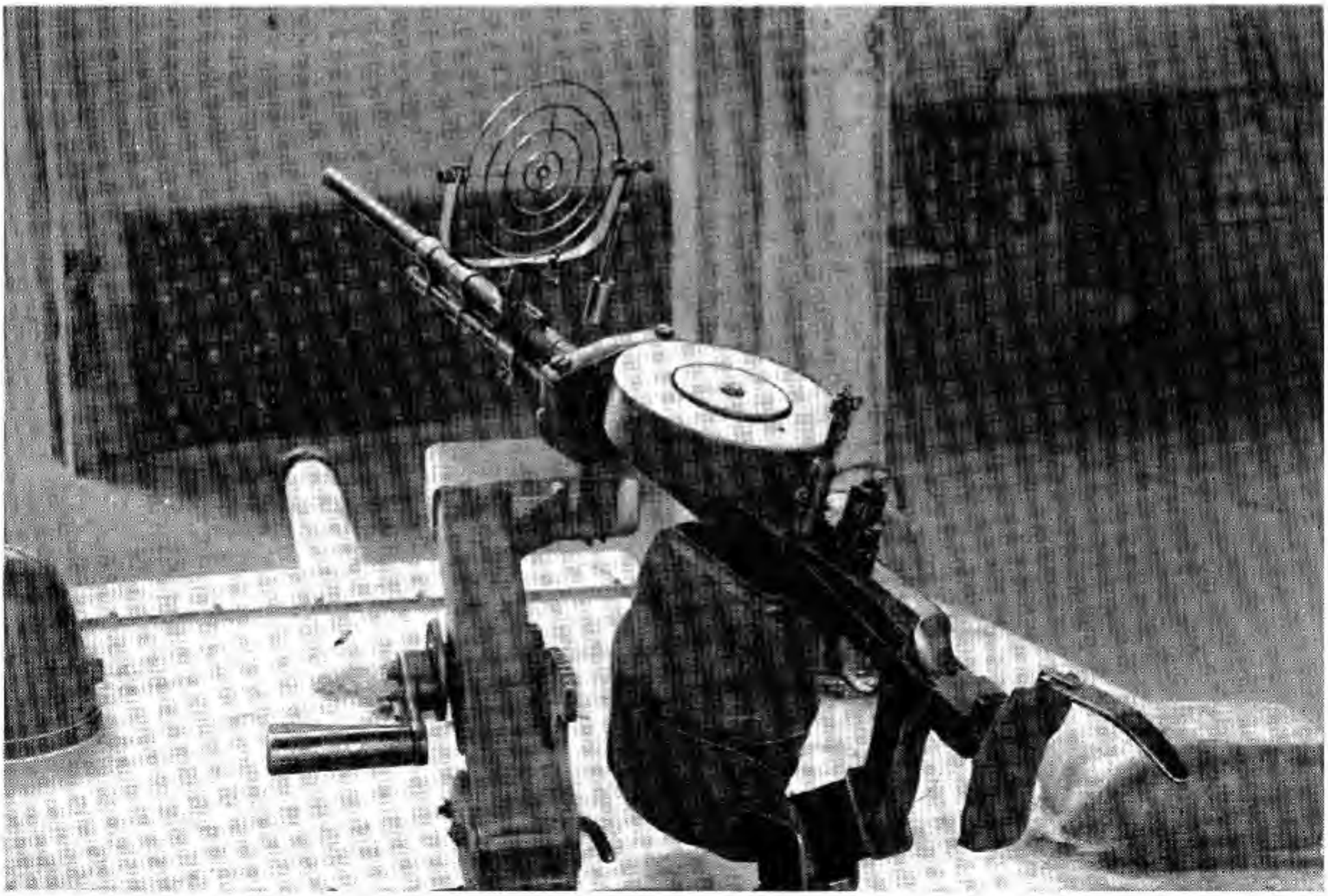

Figure 3-12. Degtyarev 7.62-mm Tank Machine Gun on tank mount with stock telescoped.

enjoy such popularity from the Air Force, especially since the latter has always leaned toward the largest gun that could be mounted in a plane.

The DA–2 is the twin mount of the DA and has been called the "SPARKA".

DT (Degtyarev Tank). The DT is the early tank version of the DP. This gun features increased magazine capacity (60-round), telescoping shoulder stock, and a pistol grip. The drum is smaller in diameter than the DP magazine, but it carries two layers of ammunition.

A bipod and a detachable front sight are used with this gun when it is utilized as a ground weapon.

The rear sight is the aperture type; it is sighted from 400 meters to 1,000 meters.

The DT barrel is heavier than that of the DP and is not of the quick-change type. A safety lever replaces the safety grip of the DP.

DPM (Degtyarev Infantry Modified). This is an improvement of the basic Degtyarev. The operating spring has been relocated because the spring heated on the DP.

The DPM has a pistol grip. The recoil spring housing extends to the rear of the receiver. The shape of the stock differs from that of the DP. The bipod has been modified and is not detachable.

A safety lever replaces the grip safety of the DP. The safety is located on the right side of the receiver above the trigger.

DTM (Degtyarev Tank Modified). This gun is a modification of the DT. The major change was moving the operating spring from under the barrel to the rear of the receiver, as on the DPM.

"Company" (Degtyarev 1946 Infantry Gun). This is the latest model designed for the ground forces. It features a detachable belt-fed mecha-

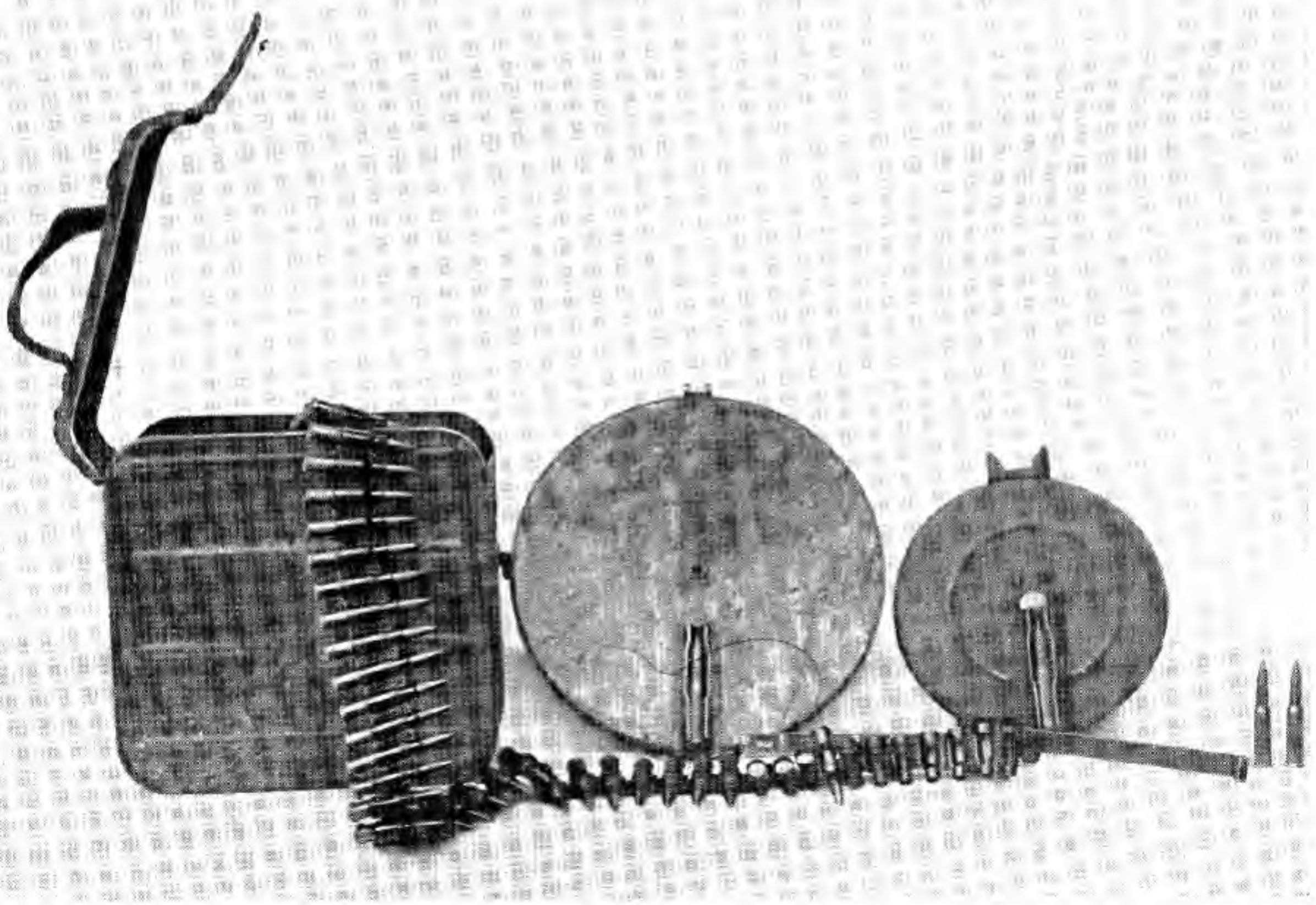

Figure 3–13. Comparison of Soviet machine gun feeds: left, ammunition box and belt for belt-fed infantry guns; center, drum for DP; right, drum for DT and DA.

nism for the use of a metallic link belt holding 50 rounds. Belts may be linked together for longer periods of sustained firing. The belt is the same as that used with the SG–43.

The standard 47-round drum can also be used with this gun. The barrel is heavier than that of the DP. The gun has a pistol grip. The bipod has been strengthened for greater stability.

DS (Degtyarev Medium). The DS which appeared in 1939 includes many improvements over the earlier designs of Degtyarev guns. It was designed for tripod mounting and, for purposes of sustained fire, had a heavy barrel with cooling rings and was belt fed.

It differs in external appearance because of its comparatively fine finish. The same system of barrel change is incorporated, using lugs on the barrel to engage in recesses in the receiver. The rear face of the barrel includes grooves shaped to receive the face of the bolt. Thus the gun cannot fire if the barrel is not in the locked position, as the bolt cannot reach battery.

The forward handle is arranged for carrying either the complete weapon or a spare barrel only. The gas port adjustment by the operator is accomplished in a very simple manner by moving an adjustment lever to either of two positions, marked 2.2 and 2.5 (diameter of orifice in millimeters).

Twin spade grips are provided for the operator. Each grip has a trigger for the index finger, but a thumb latch on the left grip must be depressed before the trigger can be pulled rearward. The right grip contains a brush and oil reservoir.

A retracting slide handle is located on the lower right of the receiver and rides in machined grooves on the outside, but this part seems needlessly engineered. On the other hand, the braided driving spring is contained in a simple sheet-metal housing outside the receiver and may be instantly removed from the gun in a single easy motion of one hand.

Figure 3–14. Soviet Tank Machine Gun DT, employed as a ground gun in World War II.

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Figure 3–15. Close-up of the receiver of the DTM. The housing for the driving spring protrudes to the rear. The year of manufacture appears just behind the rear sight.

Although the feed block is machined in a curve, this gun does not have a true rotary feed. The only purpose of the curve in the mechanism is to reduce its complexity and bulk. This mechanism, unique in this model, utilizes the motion of the piston extension, which is at the bottom of the receiver, to move the belt across the top of the receiver. The manufacturer of the curved parts was a serious production problem, since the curved shuttle operates in two similarly curved bearing slots.

Because the snatch from the belt is accomplished by twin extractors overriding the rim at 90 degrees and 270 degrees, support must be provided in the receiver at 0 degrees and in the cover at 180 degrees to prevent stubbing the noses of the rounds. The extractors maintain position control over the cartridge until it is cammed into the T-slot. This occurs during the early part of the rear stroke. The same cam is pivoted in such a way that it becomes a lever, (actuated by the rear of the bolt) and it then pushes the round down into alignment with the chamber. The unfired cartridge forces the empty case down the T-slot and out. The combination cam and lever permits the cam to be less steep.

Although disassembly is possible without tools, it is not as easy as in most guns designed in this period. All major parts bear the gun number, which is an indication of a low standard of interchangeability. There is little evidence of engineering with mass production in mind. This weapon was never

Figure 3 16. The 7.62-mm Degtyarev "Company" Machine Gun.

produced in large numbers, and it has been referred to as a failure; however, its weakness appears to have been in difficulty of production rather than in performance.

This weapon uses either a metallic belt or a canvas belt, the latter being the belt of the Maxim machine gun. For this reason, there is a rather large clearance in the feedway. The rate of fire can be adjusted by rotating the buffer.

DK (Degtyarev Heavy). This 12.7-mm gun appeared about 1934 at a time when interest in machine guns of approximately one-half inch bore was becoming very strong throughout the world. It appears to have been only a trial weapon, and its importance lies in the fact that it served as the basis for the DShK, which appeared about 1938.

DShK (Degtyarev-Shpagin Heavy). The DshK, the principal anti-aircraft defense of the Russian ground troops, was also in wide use in other branches of the Armed Forces in World War II. This weapon used the 12.7-mm rimless cartridge. In figure 3–24 it is shown in use on the deck of a small vessel of the Soviet fleet.

The feed system on this weapon was originated by Shpagin, a fact that accounts for the official designation being DShK. The first letter stands for Degtyarev, the originator of the firing mechanism, the second and third letters for the designer of the feeding arrangement, and the fourth letter for "heavy."

G. S. Shpagin, a well known mechanical engineer in the Soviet Union, was the designer of the rotary type of feed that became practically synonymous with certain types of Russian automatic weapons. This system was so widely used and with such success, the inventor received many honors from his country, rose to the rank of Lieutenant General, and was placed in charge of a large scientific research organization.

The DShK has an external appearance that differs greatly from the drum-fed Degtyarev

Figure 3-17. The 7.62-mm Degtyarev Belt-fed Machine Gun known as the DS. Very few specimens of this version are in existence.

Figure 3-18. The DS dismounted from its tripod.

Figure 3-19. The DS with the feed cover opened to permit access to the feedway.

Figure 3 20. Stripping the DS: back plate group and housing removed.

Figure 3-21. Stripping the DS, continued: sear group removed.

Figure 3-22. Stripping the DS, continued: operating slide and belt group have been removed together. The next step is the removal of the handle from its guideway.

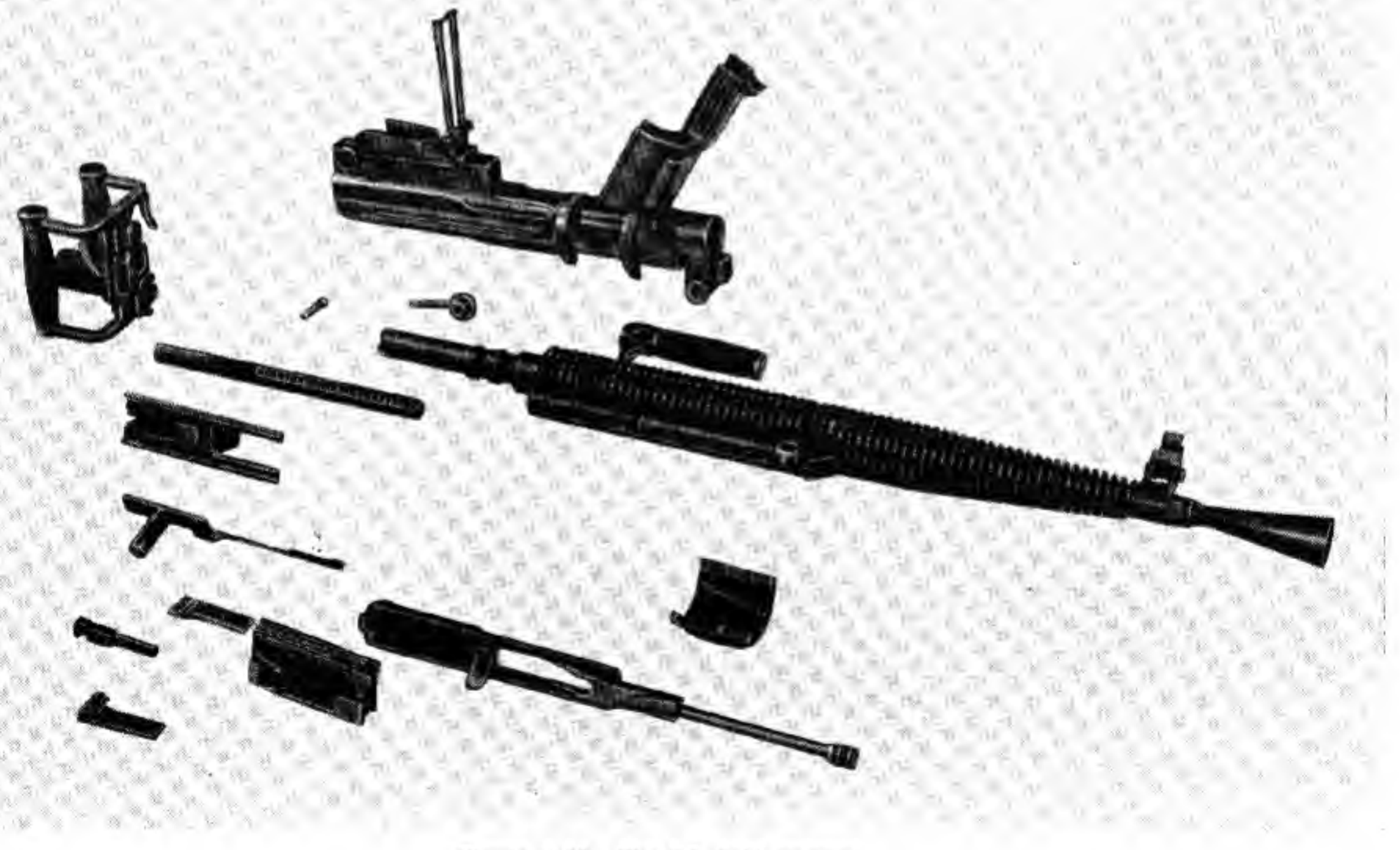


Figure 3-23. The DS, field stripped.

weapons; however, with the exception of the rotary feed, the mechanism is very similar to the drum-fed models. Although there are superficial external resemblances between this gun and the DS, the similarity in the mechanism is confined to the locking action.

Figure 3–24. The 12.7-mm DShK Machine Gun as antiaircraft defense for a small vessel of the Red Fleet. Mounted in the foreground is a turret of the type found on the Russian T34 tank.

In the DShK, rounds are stripped from the links in the rotary feed which positions them in a feed mouth from which they are stripped by the bolt in its forward travel. This feature is shown in figures 3–27, 3–28, and 3–29.

The gun has on the receiver a leaf sight for fire against normal ground targets and can also use a model 1938 or model 1941 sight for fire against aircraft or moving surface targets including those with thin-skinned armor.

The DShK is a very heavy gun, and since the barrel cannot be readily removed for man-handling, a wheeled mount is provided. The complete weapon makes an excessive load even for two men.

Barrel removal is accomplished by means of a wrench; accordingly, there are some shallow grooves near the muzzle. The barrel is screwed into the receiver until its stump rests against the inside shoulder of the receiver. When it is in the correct position lines on barrel and receiver coincide.

To keep the barrel from loosening during the vibrations incident to firing, it is secured by a locking stud, which is screwed into the receiver from the right side. The locking stud is constructed in the form of a bolt; the middle part between the threads and the conical head make possible the selection of clearances in attaching the barrel.

Interesting Features of the 7.62-mm Degtyarev Machine Guns

Russian Army manuals used in troop-training describe the firing of automatic rifles in varying bursts.

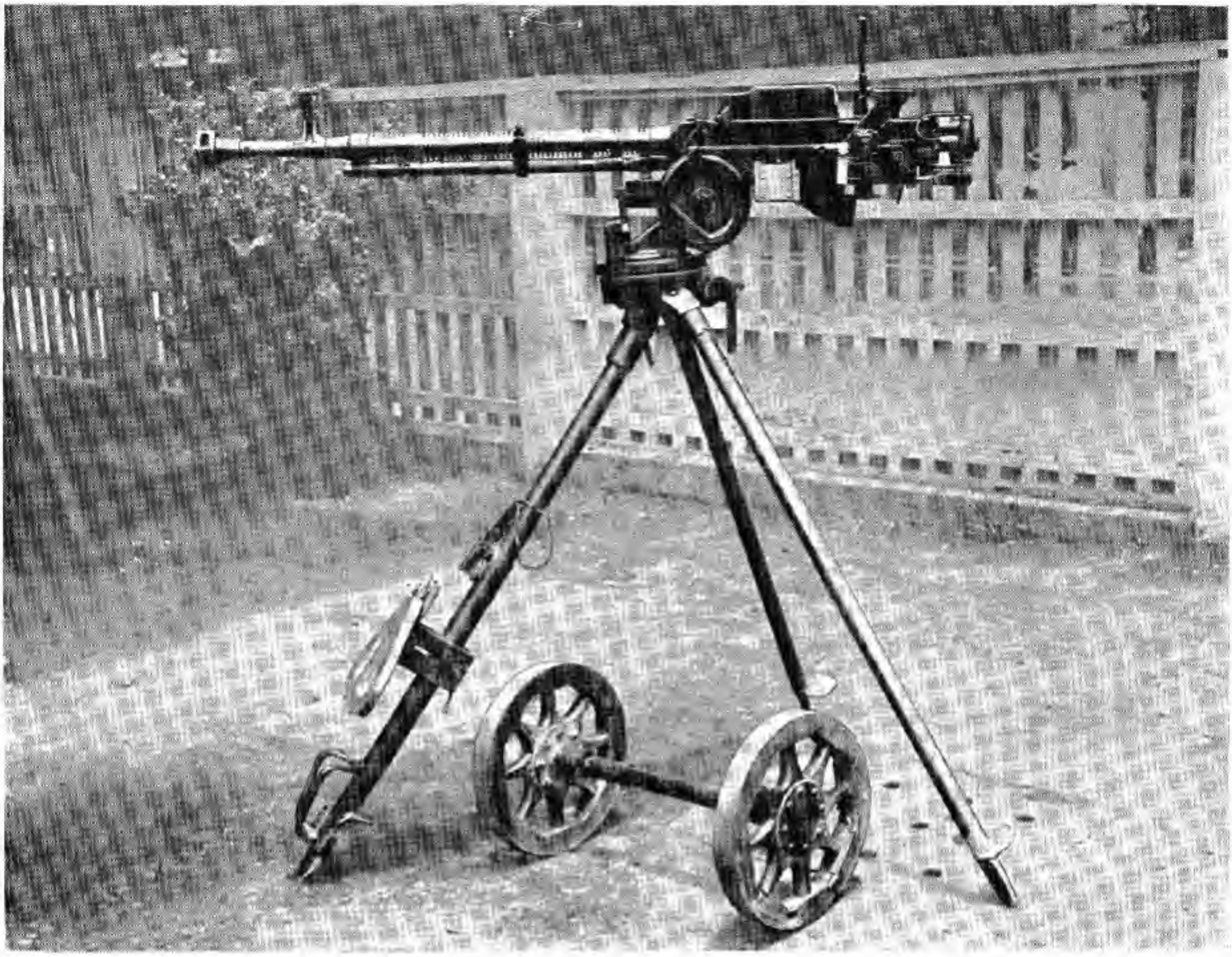


Figure 3 25. The DShk Heavy Machine Gun, mounted on its tripod for antiaircraft use.

Figure 3–26. The DShK Heavy Machine Gun, dismounted.

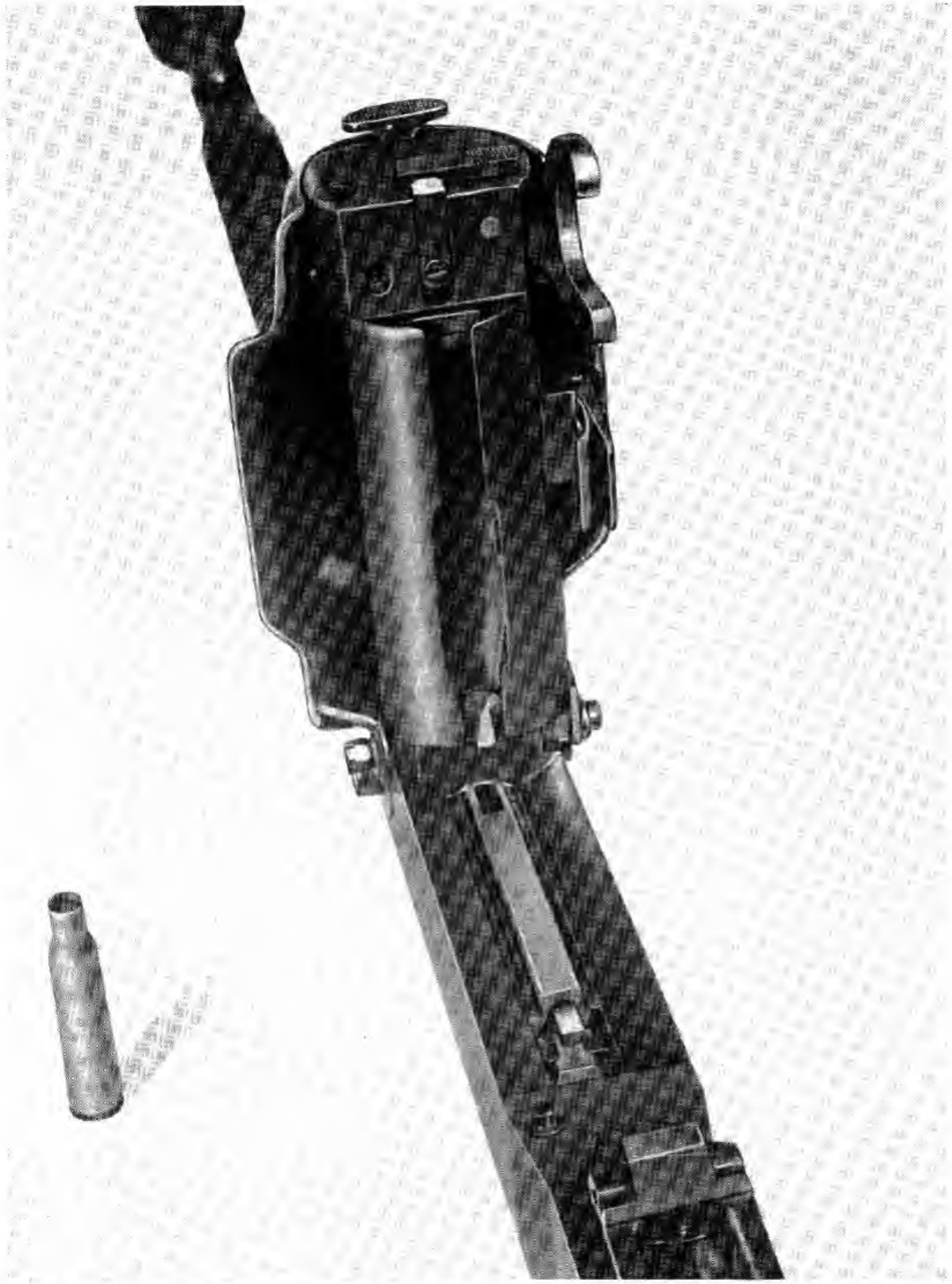


Figure 3–27. The 12.7-mm DShK Machine Gun with the entire feed hinged up, showing the lips from which the bolt picks up the round on the forward stroke. In this view, the bolt is in battery position.

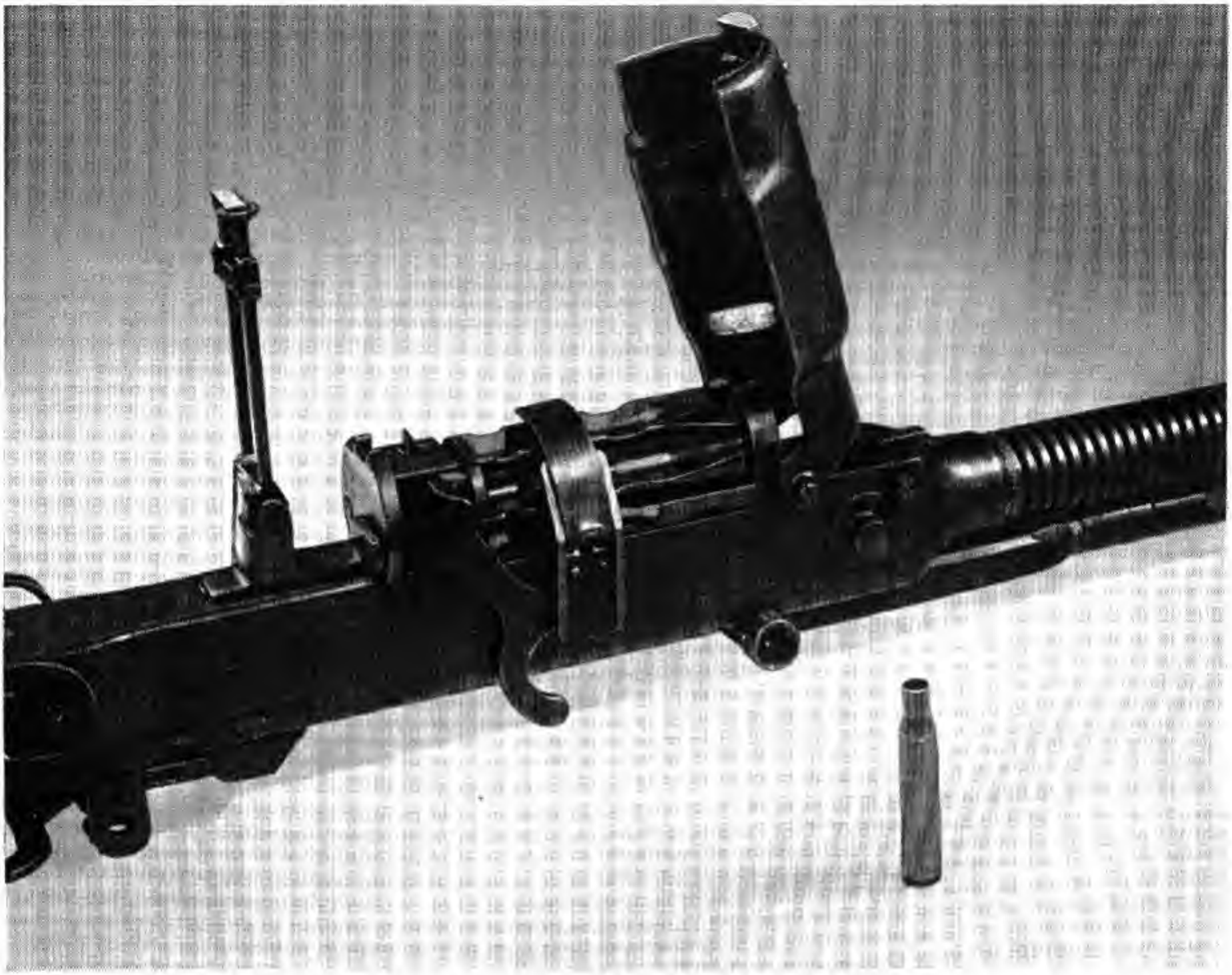


Figure 3 28. The 12.7-mm DShk with feed cover hinged up, showing the link stripper and the rotary sprocket.

The normal burst is given as four to six rounds with a shorter one of two of three shots being permissible. The whole magazine may be fired by one pull of the trigger; this is done only when desperate circumstances warrant it. Fire by normal bursts is regarded as the most expedient method, since it is very effective against most targets. Fire against small bodies of troops in skirmish line and on all very small targets can vary from short bursts to the whole magazine being expended, the choice usually being left to the discretion of the gunner.

The Soviets claim that the ballistic qualities of the Degtyarev are the same as those of their standard infantry rifle. This performance seems logical, since the trajectory of a single shot fired from the machine rifle is subjected to the same laws and influence as that of the rifle bullet.

The Soviet military authorities estimated that the normal zone of effective fire of the Degtyarev was roughly 1,500 yards and that under highly favorable conditions the maximum could be extended to 1,800 yards.

Reports describe a unique feature in the distribution of the Degtyarev machine gun. It is stated that only one gun was issued to a section, which consisted of the Commander, gunner, assistant gunner, ammunition carrier, and magazine loader. During drill, particular attention was paid to coordination and teamwork of the crew.

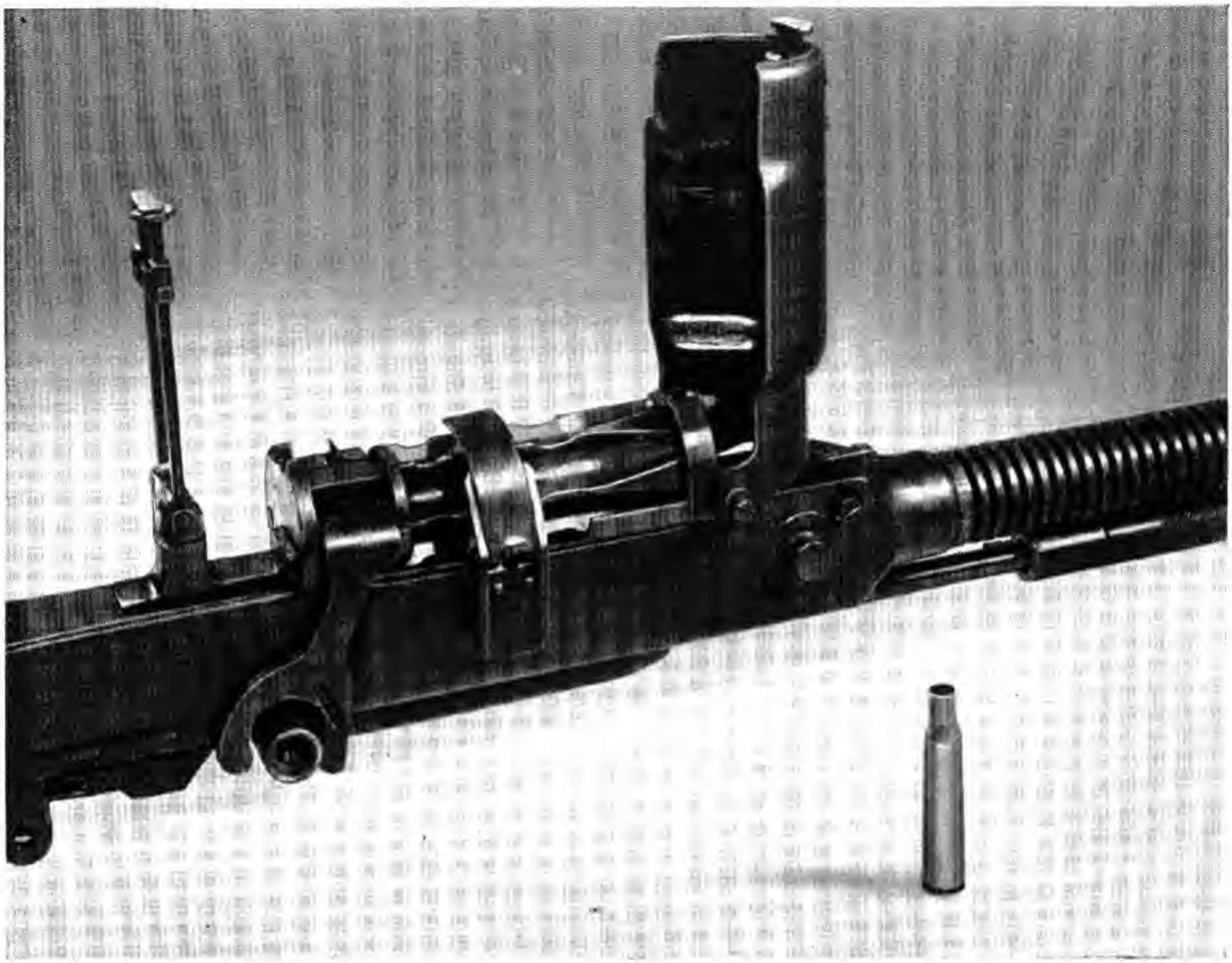


Figure 3-29. The 12.7-mm DShK with feed cover hinged up. Operating mechanism is in the retracted position. The retracting handle has driven the yoke to the rear, thus rotating the sprocket and indexing another round.

Cycle of Operation for Drum-Fed Models

To fire the drum-fed models, the gunner places a loaded drum into its holding catches on top of the receiver. The cocking handle on the right side is pulled completely to the rear until the spring-loaded hold-back engages its locking recess in the bottom of the gas piston. The weapon is now cocked and ready to fire.

By placing the right hand around the grip of the shoulder stock, the safety is depressed. Pressure backward on the trigger disengages the sear, allowing the compressed driving spring in the piston housing to pull the operating parts forward.

As the feed rib on top of the bolt comes in line with the opening in the rear of the drum feed mouth, it begins to shove the positioned cartridge out of its guideways into the chamber. The bolt reaches battery, first chambering the round and camming the extractor lip over its rim. At this point, the two swinging locks that have been holding the firing pin to the rear have reached a point opposite the locking shoulders milled in the stationary receiver. The firing pin is now free to advance, at the same time camming the locks into their recesses. The firing pin continues on through the bolt face into the primer that ignites the powder charge.

Before the bullet has left the bore, a portion of the propellant gas is diverted through a port in the bottom of the barrel into a short cuplike cylinder that houses the gas piston head. This action delivers

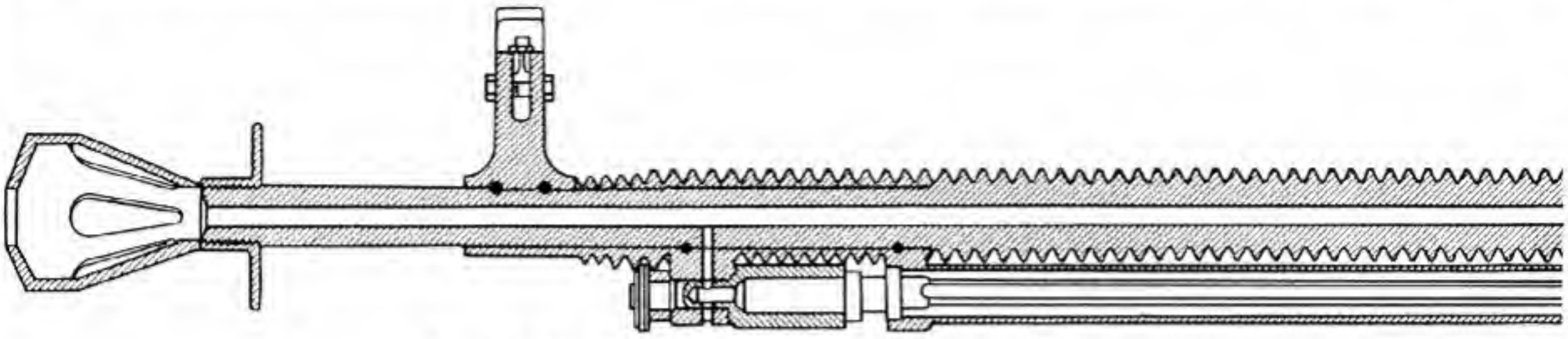


Figure 3–30. The DShK Heavy Machine Gun, sectional view.

an impact on the face of the piston, which then starts to recoil with the firing pin. After free travel for ⅜ inch, the firing pin cam is removed from the sides of the pivoting locks and the latter now folds back into the bolt body behind the firing pin, holding it to the rear. After a full inch of rearward travel, the gas piston leaves its short cylinder, and the gas that is thrusting it to rear is allowed to dissipate into the air. The first unlocking movement gives initial extraction, and the loosened cartridge case is held by the extractor until its base collides with the ejector. As a result, the empty case is knocked through the ejection slot in the bottom of the receiver. At the completion of the full recoil stroke, the cycle of operation continues as long as the trigger remains depressed.

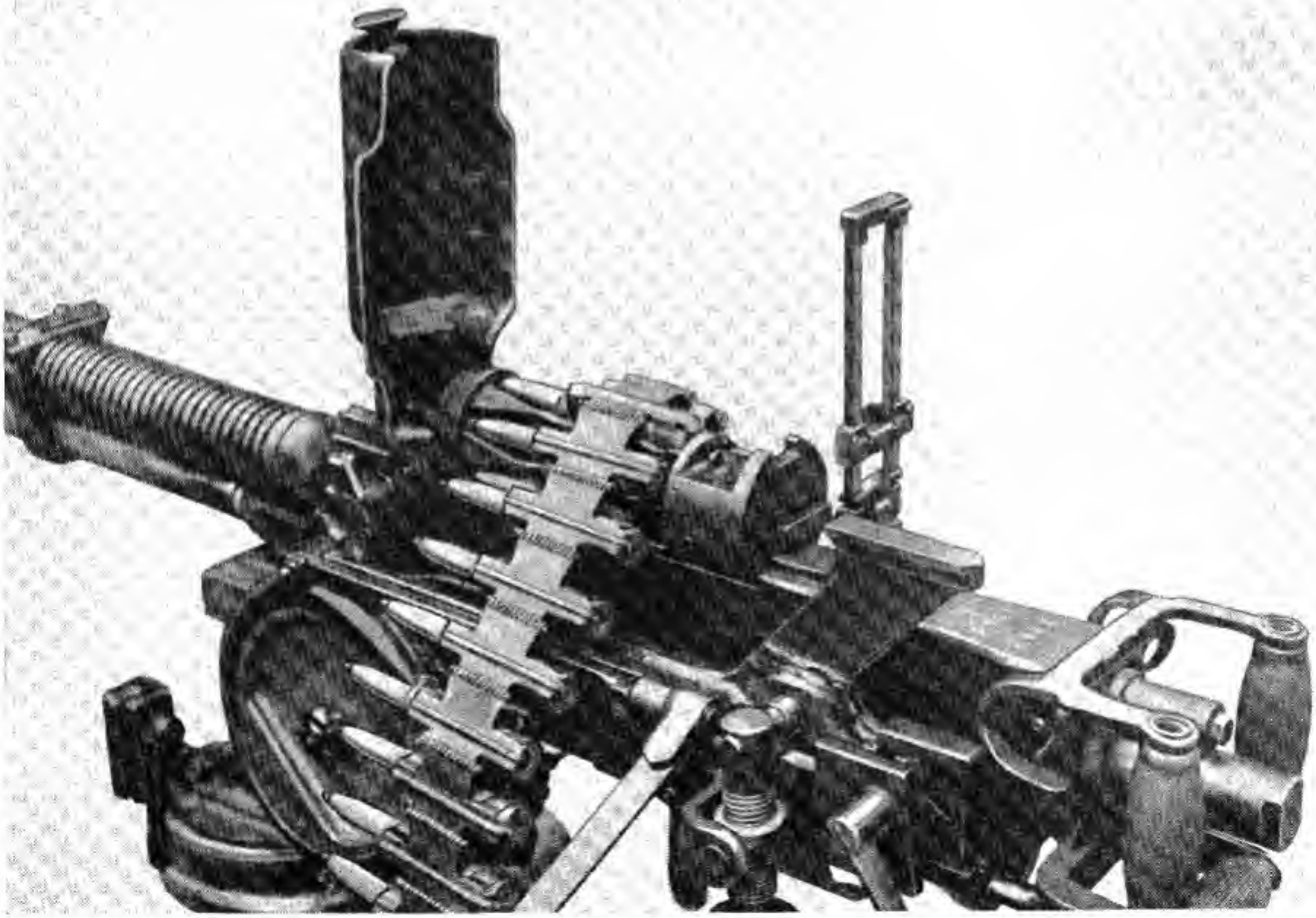
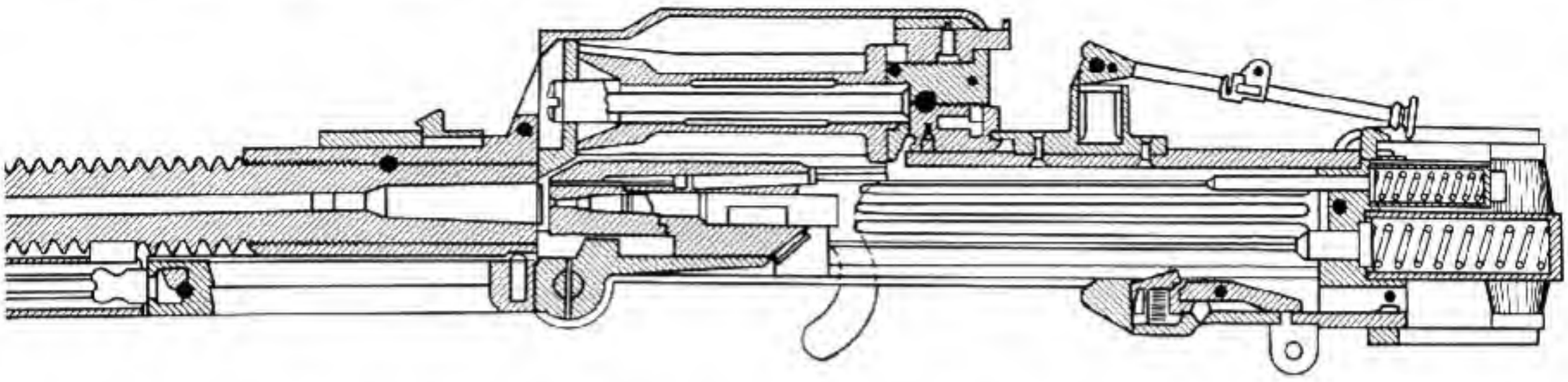


Figure 3–31. The DShK Heavy Machine Gun with feed cover hinged up, showing loaded belt positioned in rotary feed drum.



Cycle of Operation for the DS Gun

To fire the DS, the gunner retracts the bolt to the rear sear and places the first round in the belt over the belt feed pawls that are an integral part of the curved feed slide. The rim of the cartridge is positioned behind a rib in the feedway, preventing it from moving forward and stubbing when being engaged by the cartridge extractors.

The trigger is depressed, allowing the bolt to go home. As the mechanism approaches battery position, two spring-loaded jaws located in the top half of bolt body snap around the rim of the cartridge. The operating parts are now all the way home with the first cartridge held by the claws on the bolt.

The gunner again pulls the handle to the rear. Coincidental with the rearward movement, a pivoting bar arrangement that rides in the slotted portion of the bolt begins from the instant of withdrawal to cam the cartridge down into the T-slot. By the time the bolt reaches the seared position, the incoming round has been placed directly in line with the center of the chamber. The weapon is now cocked and ready to fire.

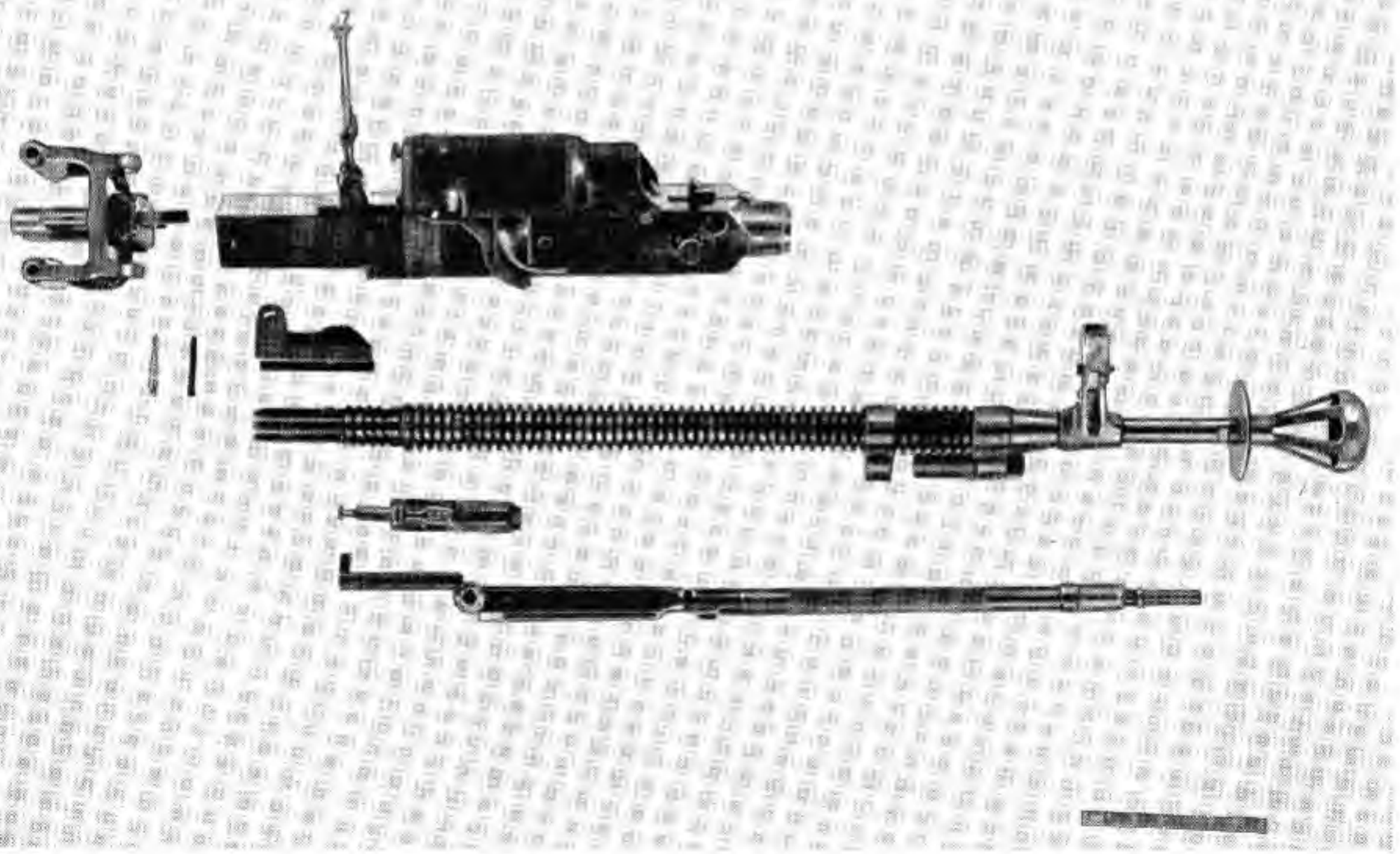


Figure 3–32. The DShK, stripped. See figure 3–23 for the difference in design of the belt-fed mechanisms of this model and of the DS.

By actuating the trigger, the bolt starts forward under compression of its driving spring, carrying the loaded round which is held securely in the T-slot on the face of the bolt. The operating parts reach home, the bolt body comes to a stop as the round is chambered.

During counter-recoil, movement of the gas piston, by which the feed system is actuated, positions the next cartridge in the belt to be picked up by the spring-loaded jaws. Since the gas piston continues to move forward when the two pivoting locks are directly alongside their recesses in the receiver, this last bit of movement of the gas piston not only cams the locks positively behind their abutments, but also causes the striker on the gas piston to come in contact with the firing pin, driving it into the primer and firing the powder charge.

The bolt continues to back up the cartridge until the gas pressure has reached a safe operating limit; at this time, the bullet has cleared the gas port in the barrel, and the gas in the barrel is metered into the gas cylinder and onto the face of the piston.

This gas pressure starts the piston to the rear with great force. As the piston starts to move rearward, its first function is to unlock the bolt. Both pieces start backwards together. With the incoming round entering the T-slot and as it is being positioned, the loaded round strikes the base of the empty case, forcing it downward out of the T-slot. The cartridge pawls in the feeder move outward to engage the next round, and the cycle continues as long as the trigger is depressed.

Cycle of Operation for the DShK Gun

To fire the DShK, the gunner raises the feed cover and places the end of the belt on the rotating drum, aligning the first link so as to engage the link stripper when feeding commences. The cover is then closed and the feed operating lever is operated by hand several times until the first cartridge has moved around to the feed lips. (During automatic fire this feed lever is operated by the retracting handle, for every shot.)

The pawl of the feed lever presses on the projection of a ratchet, on the drum, causing it to turn. There is a stop that is pressed back and engages the successive recesses in the ratchet, preventing turning of the drum backwards. In rotating, the drum steadily draws the belt with the cartridges into the feeder. The cover of the feed prevents them from being thrown upward. During firing, there are four cartridges in the drum, two of which are still in their links.

The weapon is cocked and ready to fire. With the actuating of the trigger, the bolt moves forward under tension from its driving spring and the feed rib pushes the incoming round forward. The bullet slides along a shoulder until the case reaches its opening. At this point, the bullet is aligned and starts into the chamber. The bolt reaches battery, first chambering the round and engaging the cartridge with the extractor lip snapping into the cannelure.

The two swinging locks that have been holding the firing pin to the rear have reached a point opposite the locking shoulders milled in the receiver. The firing pin now advances, at the same time camming the swinging locks into their recesses. The gas piston carrying the striker continues on to drive the firing pin into the primer, exploding the propellant.

As the bullet passes the gas port in the barrel, gas is diverted through a port into the gas cylinder that houses the gas piston head. This gas delivers an impact to the face of the piston, which starts to recoil and carries the firing pin with it. After free travel for 5/8 inch, the firing pin locking cam is removed as an obstruction from the sides of the swinging locks, which now fold back into the bolt body.

The first unlocking movement gives initial extraction, and the loosened case is held by the extractor until its base collides with the ejector. As a result, the empty case is knocked through the ejection slot in the bottom of the receiver. The operating parts continue rearward until they strike the buffer; then they begin counter-recoil. The cycle of operation continues as long as the trigger remains depressed.

Disassembly of the DP by Groups

Barrel. Pull the slide to the rear until caught by the sear. Press in on the barrel lock, which is on the left front side of the receiver. Turn the barrel 1/16 turn to the right and remove from the receiver.

Stock and Trigger Guard. Pull the trigger, allowing the slide to go forward. Remove the trigger guard bolt located on the right side of the receiver by unscrewing counterclockwise, and rotate the stock and trigger guard downward until the rear of

the trigger guard clears the receiver. Then remove the stock and trigger guard assembly to the rear.

Gas Piston, Slide, and Bolt. Press forward on the recoil spring sleeve and move ⅓ turn to the left. This sleeve is located at the rear of the gas cylinder tube. Now pull the slide, gas piston, and bolt out of the rear of the receiver.

Detailed Disassembly of the DP

Barrel. Unscrew the flash hider from the barrel. Remove the cotter pin from the gas cylinder nut and unscrew the gas cylinder nut. Slide the gas cylinder to the rear of the gas cylinder body. Drift out the two gas cylinder body pins and slide the gas cylinder body off the front end of the barrel.

Stock and Trigger Guard. Remove the three stock screws from the trigger guard (one screw is on the top tang of the trigger guard, one on the bottom tang, and the third on the inside of the trigger guard behind the end of the sear). The stock is now free to be removed. Drift out the trigger pin and remove the sear, sear spring, and trigger. Drift out the safety pin and remove the safety and safety spring.

Gas Piston, Slide, and Bolt. Lift the bolt from the top of the slide. Remove the firing pin from the rear of the bolt. Remove the bolt locks from the right and left sides of the bolt. Lift up on the front lips of the extractor. Pull the recoil spring to the rear of the gas piston and unscrew the gas piston. Slide off the recoil spring and recoil spring sleeve. Drift out the gas piston rod and unscrew the gas piston rod from the slide.

Receiver and Barrel Jacket. Drift out the rear sight pin and remove the rear sight leaf slide, the two slide locks, and the two slide lock springs. Drift the rear sight leaf spring to the front, and remove. Unscrew the rear sight base screw, and remove the base. Drift out the magazine latch handle pin and remove the handle. Slide the magazine latch to the front, removing it from the rear sight base. Remove the magazine latch spring. Lift up the front end of the ejector spring and slide it forward, removing it from the receiver. Lift out the ejector. Unscrew the barrel lock nut, using a screwdriver. Remove the barrel lock spring and barrel lock. Unscrew the front sight base screw, removing the base at the same time. Unscrew the front sight post.

Assembly

To reassemble the parts of this gun, the disassembly procedures just given are reversed.

SECTION 2. GORYUNOV MACHINE GUN

General Data on SG–43 (Stankovaya Goryunov 1943)

Caliber: 7.62-mm.
Rate of fire: 500–700 rounds/minute.
Muzzle velociy: 2,620 feet/second with heavy pointed ball (yellow tip) bullet.
Gun length: 44¾ inches.
Gun weight, with tripod less shield 77 pounds 14 ounces.
System of operation: Gas piston actuated.
System of locking: Propped bolt.
System of feeding: 250-round canvas belt or multiples of 50-round metallic link belt.
Method of charging: Manual.
Method of cooling: Air.
Rate control: Gas port type.
Barrel length: 28 inches.
Barrel removal: Quick change.
Chamber pressure: 44,000 psi (maximum).
Bore:
  Number of grooves: 4.
  Grooves depth: 0.015–0.021 inch.
  Groove width: 0.375–390 inch.
  Pitch: 5° 41′.
  Direction of twist: Right hand.
  Form of twist: Standard.
Method of headspace: Wedge barrel lock.
Location of feed opening: Top.
Location of ejection opening: Left side.

Description of the Weapon

The Russians hailed the SG–43 as an entirely new machine gun in every detail. Its exterior finish was crude, resembling in this respect the DP (Degtyarev Infantry) Gun. Some of its operating features were new to Russian weapons; they remind gun connoisseurs of principles and patents originated earlier by designers in other countries.

The weapon's general system of operation may be described as gas piston actuated with propped breech locking. The bolt comes to battery first, and the continued advance of the gas piston cams the rear end of the bolt over in front of its locking shoulder. This shoulder is in the right side of the receiver.

Backing up the bolt from the side of the receiver has been frowned upon by earlier machine gun designers because side loads are transferred to the normally thinner walls of the receiver. However, Goryunov used this idea with apparently no bad effects on either the over-all functioning of the gun or its components.

This principle was patented by John M. Browning of 20 August 1895 (Patent No. 544637), but he never saw fit to put it into use. In Goryunov's hands, this easily constructed locking system became the heart of a heavy machine gun system that is serving well the Soviet Army.

The piece that locks and unlocks the barrel is constructed so that when it is driven back into position a slightly angular surface takes up all slack in the barrel, forcing the aft end of the piece rearward until it butts against the locked bolt face. This simple and unique method of head space is used in

Figure 3–33. Soviet small arms designer Peter Maximovitch Goryunov (deceased).

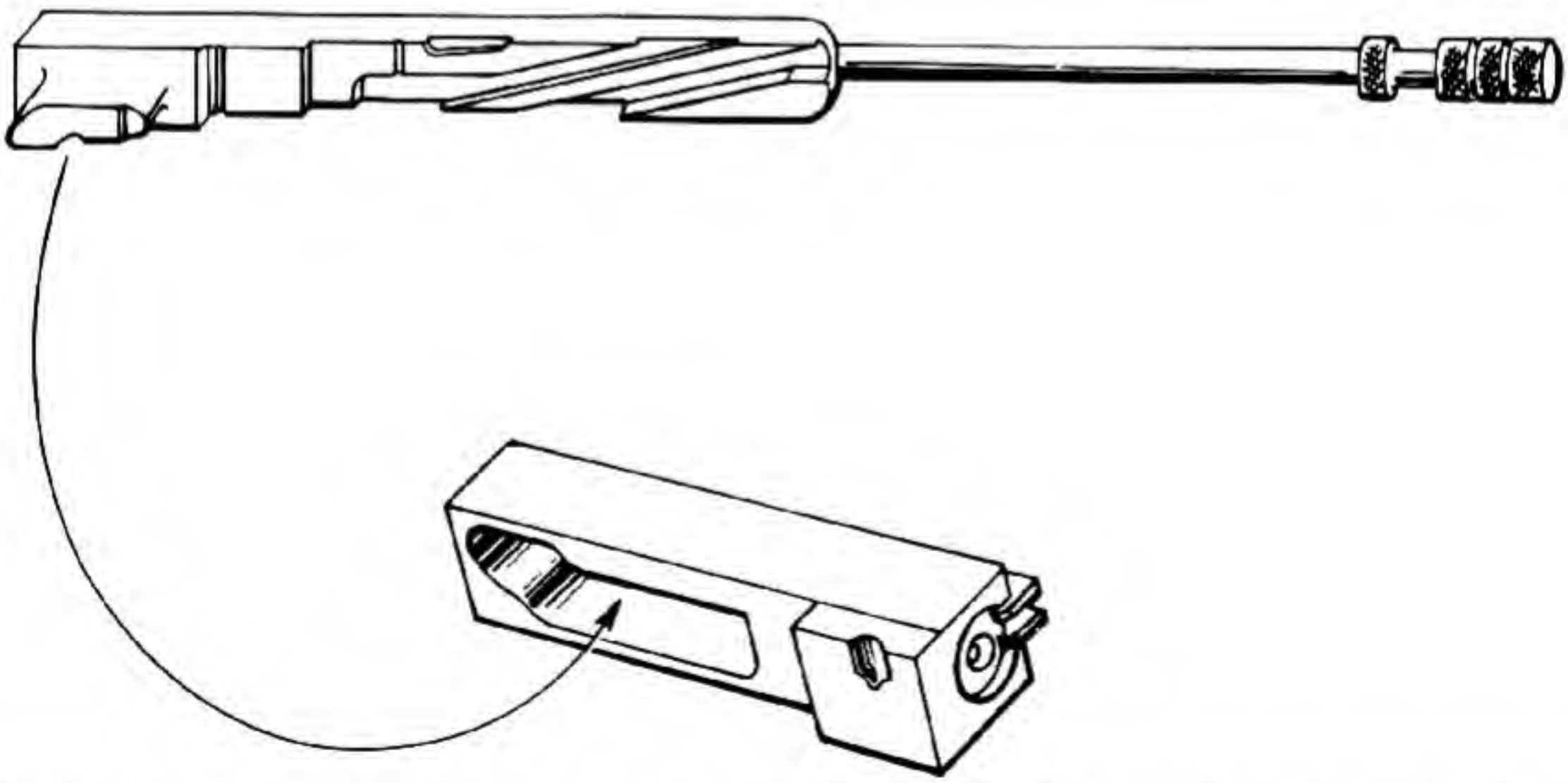


Figure 3–34. The Goryunov Machine Gun, showing operating slide (top) and bolt (bottom). The stud on the slide operates in the bolt slot to cam the bolt behind the locking shoulder.

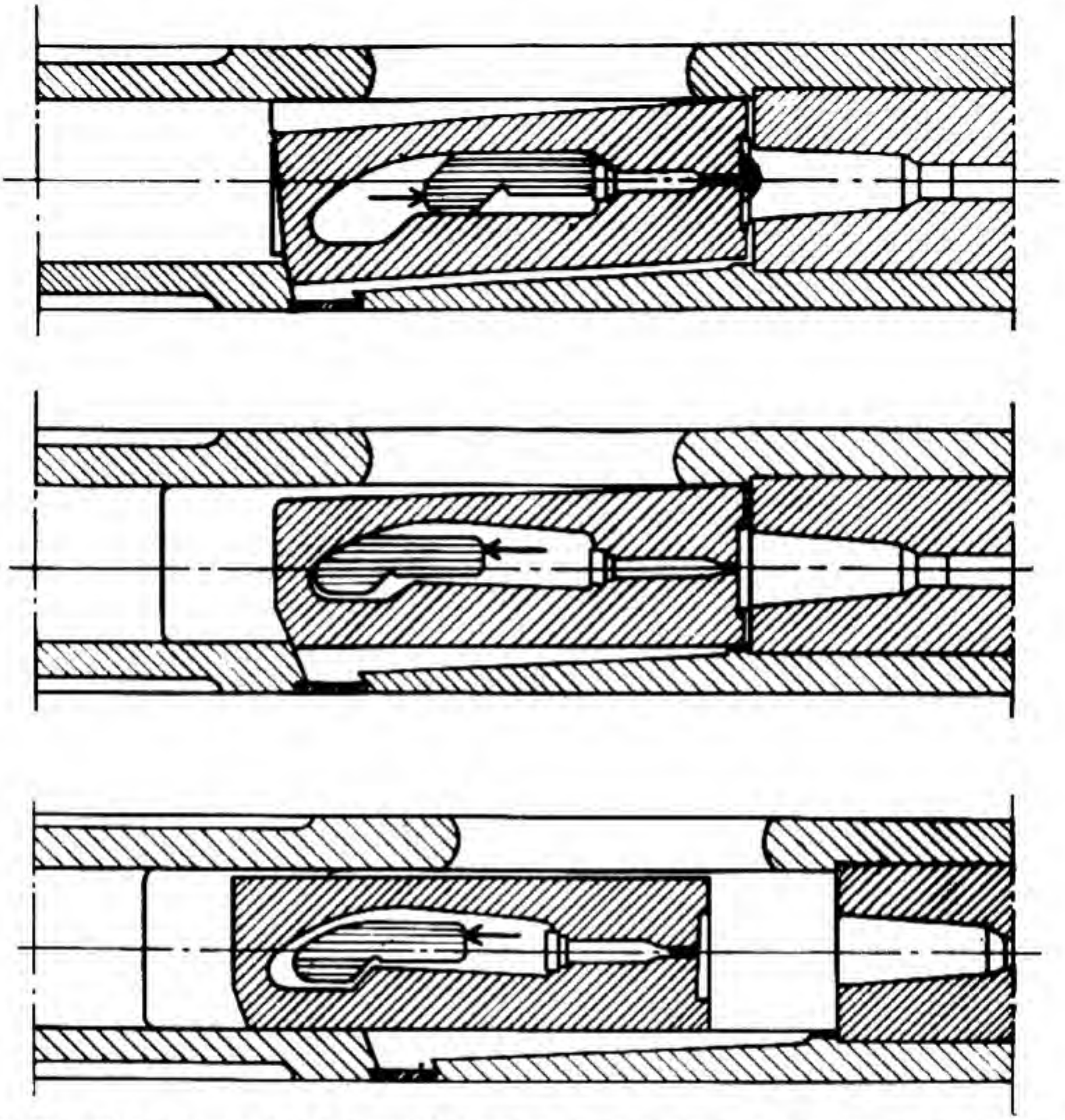


Figure 3–35. Plan of locking feature of the Goryunov Machine Gun. The steps shown are, top to bottom: ignition phase; unlocking; rear stroke.

many Soviet weapons. This method not only gives a very quick and practical fool-proof method of arriving at this critical measurement but also saves much intricate machine work such as the threading of the aft end of the barrel, serrated notches, and locking springs. While this system has a few disadvantages, its good features outweigh the bad ones.

The quick-change barrel of the SG–43 has a desirable safety feature. The barrel lock piece is located with the feedway in a position that requires the mechanism to be raised on its pivot before the barrel can be released.

When a barrel is inserted, the barrel holding device must be in the locked position before the feed mechanism can be lowered. Although with this arrangement firing a round is possible with the barrel securing piece completely removed from the receiver, this danger is no worse than the possibility of firing a round in the T-slot without a barrel in the gun, which can be done in certain well known machine guns.

The barrel handle can be used to remove a hot barrel, but it is too far forward of the center of gravity to be suitable for carrying the complete

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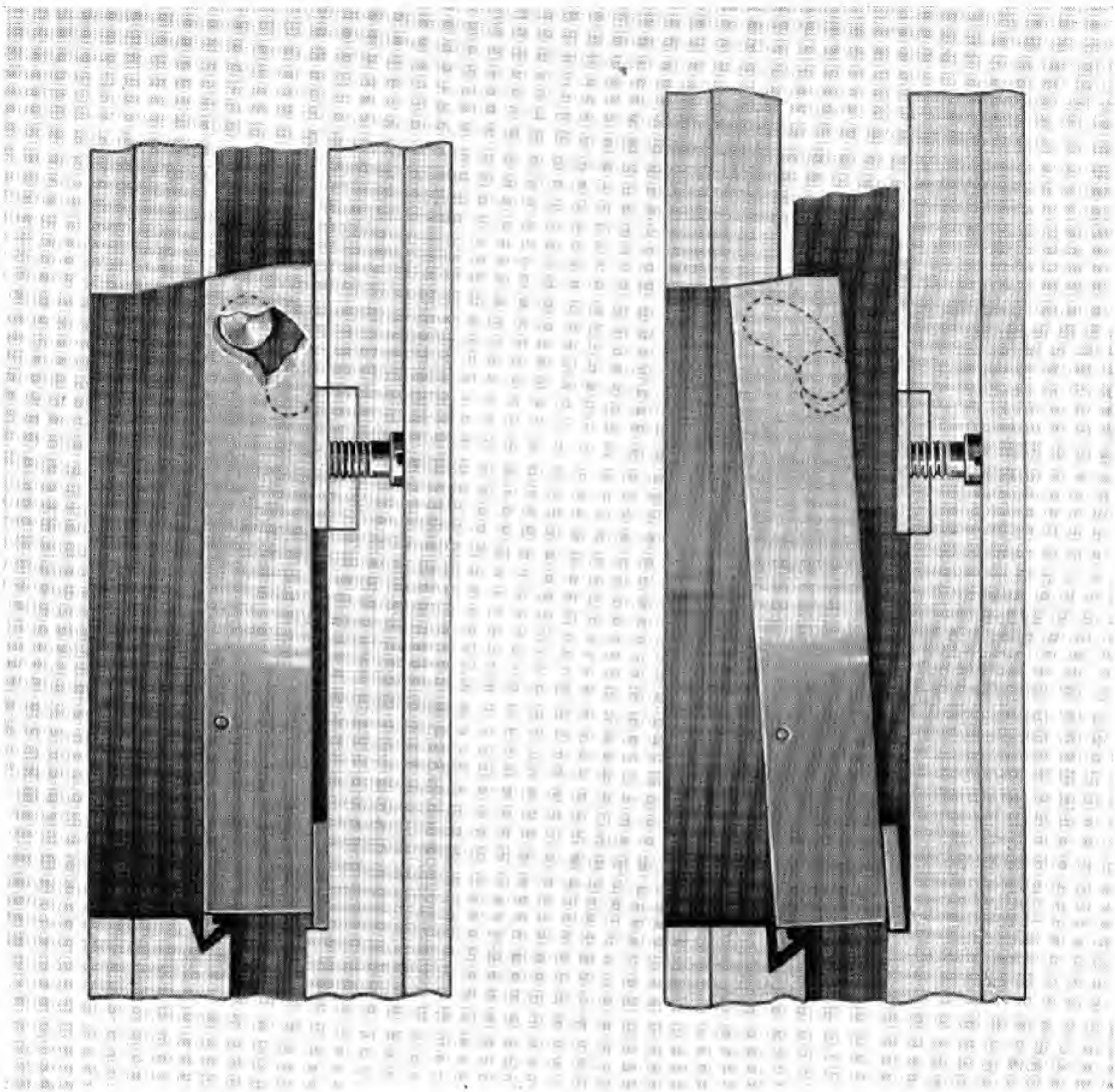

Figure 3-36. Plan of a locking feature patented by the American Gunsmith John M. Browning. This patent antedated the Goryunov lock by almost fifty years.

weapon. To make the barrel exchange easy, the cylinder connection to the receiver is flexible, and the piston is not rigidly connected to the operating slide of which it is an extension.

A feature of this weapon's construction which is found in few machine guns is the ejecting of the empty cartridge case on the recoil stroke. This is accomplished by a piece that juts through the bolt face striking the empty cartridge case on its base, causing it to be thrown through a parallelogram-shaped opening in the left side of the receiver wall. Up to this point the cartridge case is held securely

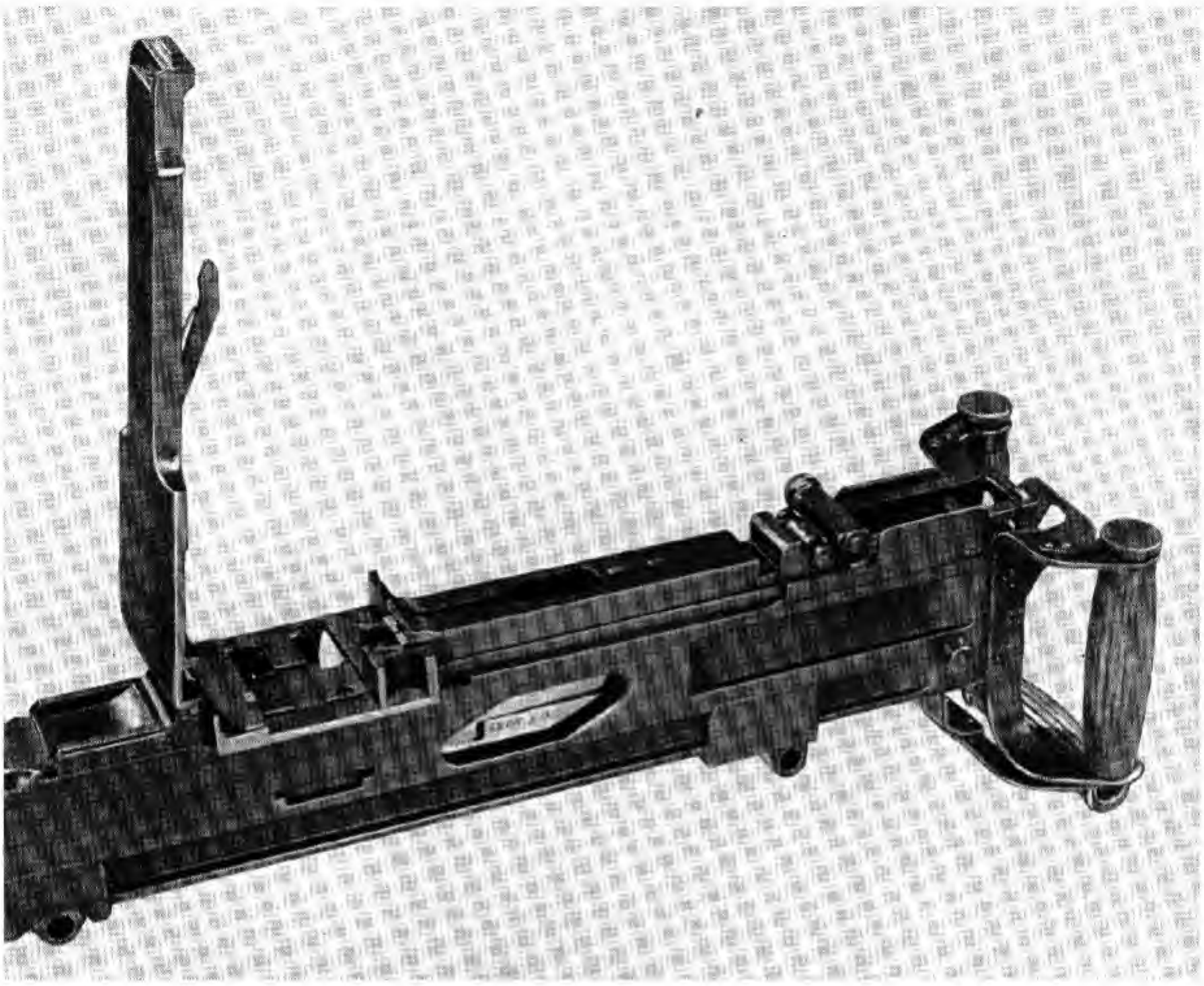

Figure 3-37. Receiver of SG-43 with cover open. Left side view showing cam which forces rounds down into the two-stage feed. Ejection takes place through the large diamond-shaped slot on the side of the casing.

to the bolt face by the conventional type of extractor, its spring-loaded lip snapping over the rim of the case.

The ammunition used in this model is the 7.62-mm standard infantry rifle cartridge. It is generally contained in a metal can manufactured specifically to hold multiple metallic belts of already linked cartridge and so designed that the top of the cam hinges back to permit it being closed at the end of a burst or at any time to keep out rain, dust, or any other foreign matter. The old-style canvas belt can be used in an emergency.

During the initial phase of feeding, the rim of the cartridge is brought to bear on a rib in the floor of the feed, bringing the round to a position whereby the rim positively stops its forward movement. This prevents a "short round" from being formed by jamming the body of the bullet down into the throat of the cartridge case. By holding the rim solidly, the spring-loaded jaws, located on the upper portion on the front part of the bolt face, can snap around the cannelure of the cartridge, putting the base into a device which has the efficiency of a T-slot. This is an unusually simple way to accomplish what was heretofore considered to be a very difficult act; however, its value is problematical since a rimmed cartridge is required.

The bracket that supports the gas chamber is

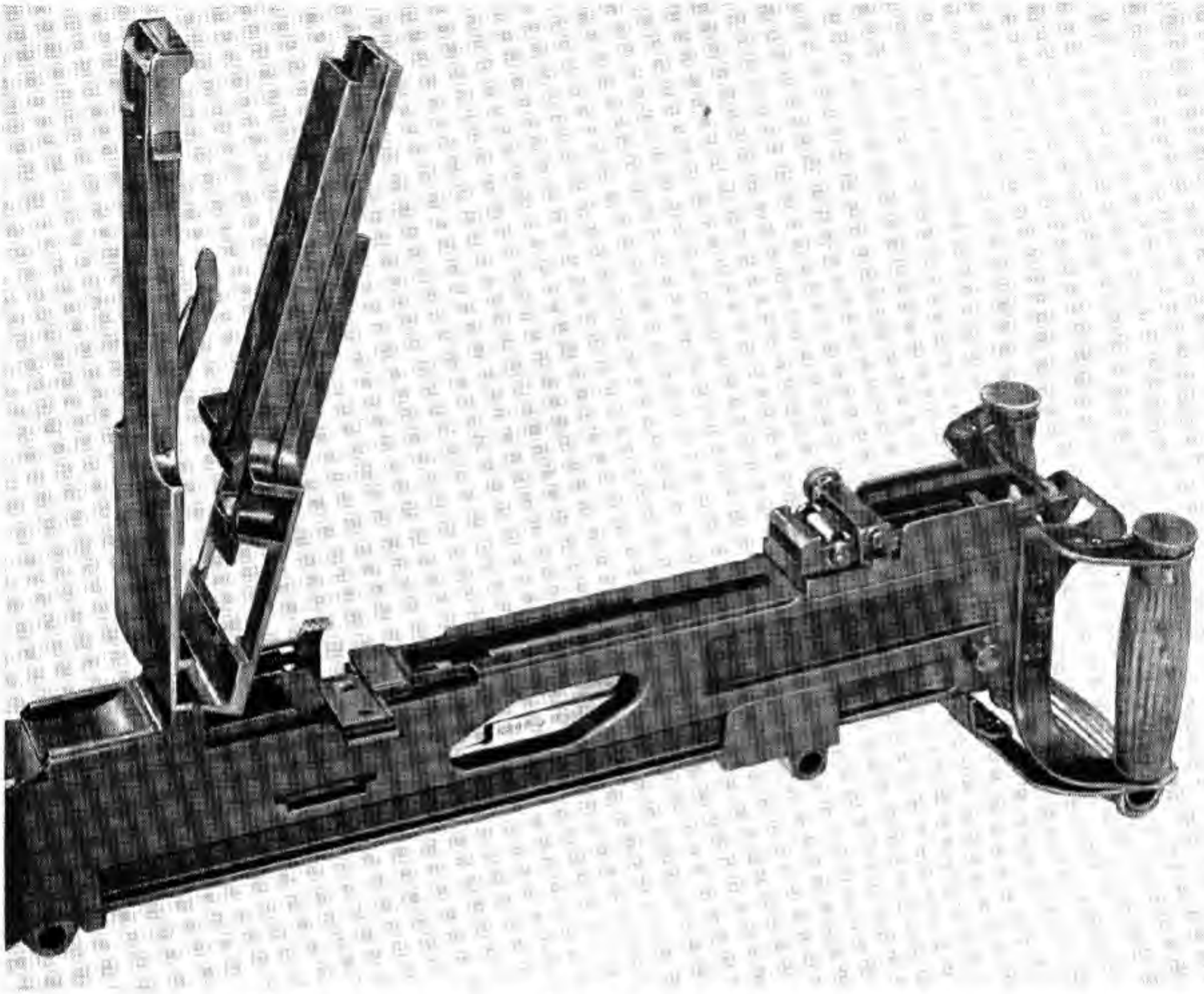

Figure 3 38. Receiver of SG 43 with cover and feedway hinged up to permit barrel securing wedge to be pulled out to release the barrel.

designed so that the operator can make a choice in rate of fire, allowing him to speed up or slow down the gun at will. This feature was thought necessary by the Russian High Command since so much of their fighting was expected to take place in extremely low temperatures. By opening the gas port, a gun that was sluggish from the cold could be given more operating power until it had time to warm up.

This weapon includes an advanced feed design, a development necessitated by the rimmed 7.62-mm cartridge which its uses. Since a solid T-slot machined on the bolt face could not be used and a push out belt is not possible with rimmed cartridges, a method of feeding in several stages was devised by which the round remains under mechanical control at all times, even when the gun is fired inverted.

In the first stage, spring loaded jaws take a firm grip on the round in the feedway and draw it rearwards. As the moving parts reach the rearmost position, the round is forced down by a spring loaded rib under tension into engagement with the extractor recess.

The second stage occurs during forward motion when the top rib of the bolt moves through the lip and rams the cartridge into the chamber. As the round is chambered, the ejector snaps over the rim of the case.

The front of the bolt is countersunk to receive the base of the cartridge; a clearance cut is provided

to prevent binding when the bolt locks. This cutting is done on the barrel to avoid cutting away of the circumference of the countersink on the bolt.

The belt feeding pawl is operated directly by the slide. This arrangement results in an undesirable protrusion of this assembly from the right of the gun. A cover spring is employed to hold up the cover when desired, somewhat in the manner employed on American type machine guns. The combined mounting bracket and stirrup are also reminiscent of the standard United States gun.

The absence of a buffer is best explained by the comparatively heavy slide. This gun fires from an open bolt so there is no danger of cook-off. This weapon can be fed only from the right side. Those in authority believe that to do otherwise would involve the manufacture of intricate parts, an effort not worth the cost.

The Soviet Army's favorite method of mounting is on their familiar low-wheel cart of the Sokolov type, which has a shield in front to protect the gunner operator from shell fragments and grenade particles, and even offers protection to a limited degree from rifle and machine gun fire. The weapon uses the improved version of the 1931 "Universal" type tripod.

A small metal hand-operated wheel located directly underneath and to the rear of the receiver allows the muzzle to be raised or depressed at will. The charging rod with its assembly is located underneath the operating slide and fits in the longitudinal grooves in the receiver. To charge the piece, the handle of the rod is pulled smartly to the rear until the piston is engaged by the sear. Now the handle is shoved forward into position.

The spade grip handles are very similar to practically all contemporary machine guns. However, the addition of the charging handle at the bottom gives the weapon a peculiar appearance.

The rear sight is graduated from 0 to 2,300 meters for the 1930 heavy ball round and from 0 to 2,000 meters for the 1908 light ball round.

Various markings appear on the receiver cover. The number of the weapon is stamped on the forward portion of the receiver.

Several reasons are immediately apparent why a T-slot could not be used on the bolt face. The locking action includes a displacement of the rear of the bolt to the right. To allow for this motion, a T-slot would have to be made with a loose fit around the cartridge head. The position of the operating slide caused interference, so it was necessary to use a Mauser type extractor and ejector and throw the empty cases to the left. This extractor rises over the rim of the cartridge just as the parts are coming into battery.

Doing away with all unnecessary springs is one of the greatest accomplishments of Goryunov; in fact, the driving spring and its telescoping guide, which is also spring loaded, are about all the springs employed for the gun's operation. In the event of a feed malfunction, the gunner can quickly unlatch the cover and by simply raising it up can get to the offending cartridges or links.

A cone-shaped flash hider is screwed to the threaded portion on the muzzle end of the barrel and helps to a great extent to keep the flame from the exploding powder charge from giving away the gun's position. This device is practically identical with the ones found on other Soviet machine guns and automatic rifles. Use of this device is more common at night when the wheel mount is converted into an antiaircraft mount. In this application abnormally long bursts are often necessary, in which there is a tendency for the flash to increase.

Cycle of Operation

To fire the SG-43, the gunner checks to see that the bolt is to the rear, then inserts in the feedway the cartridges contained in a flexible metal belt. He then positions the first cartridge to the left as far as possible, or until the belt holding pawl snaps behind the second round in the belt.

The gunner then actuates the trigger, allowing the action to go forward. The rim of the positioned cartridge being held top and bottom by the rib in the feedway permits the jaws of the cartridge pulling device to snap around the rim of the round. By retracting the action again, the cartridge is pushed down out of the grooves into a feed mouth to be picked up by the face of the bolt. The weapon is now cocked and ready to fire by pulling back on the trigger.

The firing mechanism starts forward, driven by the energy of the compressed driving spring. The angular cams on the gas piston extension start the movement of the two spring loaded cartridge hold-

ing pawls to the right until they are behind the second round in the feedway. Continued travel towards battery starts the chambering of the round which is completed with the bold arriving at the end of its counter-recoil movement.

At this moment, the rear end of the bolt body is shoved over into its locking recess in the receiver by the influence of a projection located on top of the gas piston riding in a curved slot in the bottom of the bolt.

The rear end of the bolt is now tilted over and it removes the obstruction that holds the gas piston retracted for a fraction of an inch. It starts forward and continues until stopped by the lug on the gas piston coming in contact with the firing pin driving it into the primer. This sequence just stated discharges the weapon.

The bolt is held securely locked behind the fired cartridge until chamber pressure reaches a safe operating limit. This factor is controlled by an orifice metering gas onto the face of the piston. Impact on the face of the piston starts the operating components rearward. The first fraction of an inch, the operating parts have free travel. Then the lug on the piston engages the unlocking slot in the bolt, pulling the aft end of the bolt out of engagement with its recess and drives the whole assembly rearward at great speed.

The first part of the unlocking action withdraws the lug from behind the firing pin, which retracts from spring pressure. The extractor claw pulls the cartridge from the chamber and holds it against the bolt face until the bolt travel is stopped; at this point, a pin protrudes through the bolt face pivoting the empty case through the ejection slot in the left side of the receiver.

As the gas piston starts to the rear, its grooves engage its corresponding ribs in the receiver body and move the feed floor towards the center of the feedway. As the gas piston reaches its position of rearmost travel, the rim of the cartridge is held top and bottom by the rib in top and bottom of feed way. The spring loaded jaws, located at the top, on starting to the rear pull the first round from the belt. Then a pivoting member in the feed cover pushes the loaded round down and into a form of feed mouth from which it is picked up and shoved into the chamber. The procedure is continued as long as the trigger is depressed.

Disassembly

To disassemble the SG–43, perform the following steps.

1. To open cover: Push the cover latch of the receiver forward, open cover and raise it upward.

2. To separate the frame of the receiver and slide from the base of the receiver: Raise the base of the receiver and remove the frame and the slide from the grooves of the base; move the base of the receiver forward to the cover; remove the slide from the frame.

3. To separate the backplate from the receiver group: Clasp the linch pin of the backplate with left hand and with the right hand move the handle a little to the right; while holding the backplate with the left hand of the left handle pull out the linch pin of the rear plate with the right hand, pulling the lower of the rear plate toward the body with both hands, push down slightly, and separate it from the receiver group; remove recoil spring from guide rod.

4. To raise the locking stud of the barrel: In order to disengage the barrel, raise the locking stud to the left as far as possible and leave it in a raised position.

5. To separate the belt feed slide from the receiver group: With the fingers of the right hand grasp the belt feed slide and lift it from the receiver group.

6. To remove the slide from the receiver group: Pull the slide back to the end of the receiver group, with the reloading handle. Grasp the bolt and frame with the left hand, lift them from the receiver group and remove the bolt from the frame; slide the reloader handle from the grooves of the receiver group.

7. To separate barrel from receiver group: While raising the rear plate of the barrel, shift the barrel forward by the handle until it is disengaged from the receiver group.

Field Stripping

This process involves the removing of the locking pin from the butt plate, removing the plate, and pulling the charging lever to the rear. This action withdraws all parts of the firing mechanism.

Assembly

To assemble, use the steps of disassembly in the reverse order.

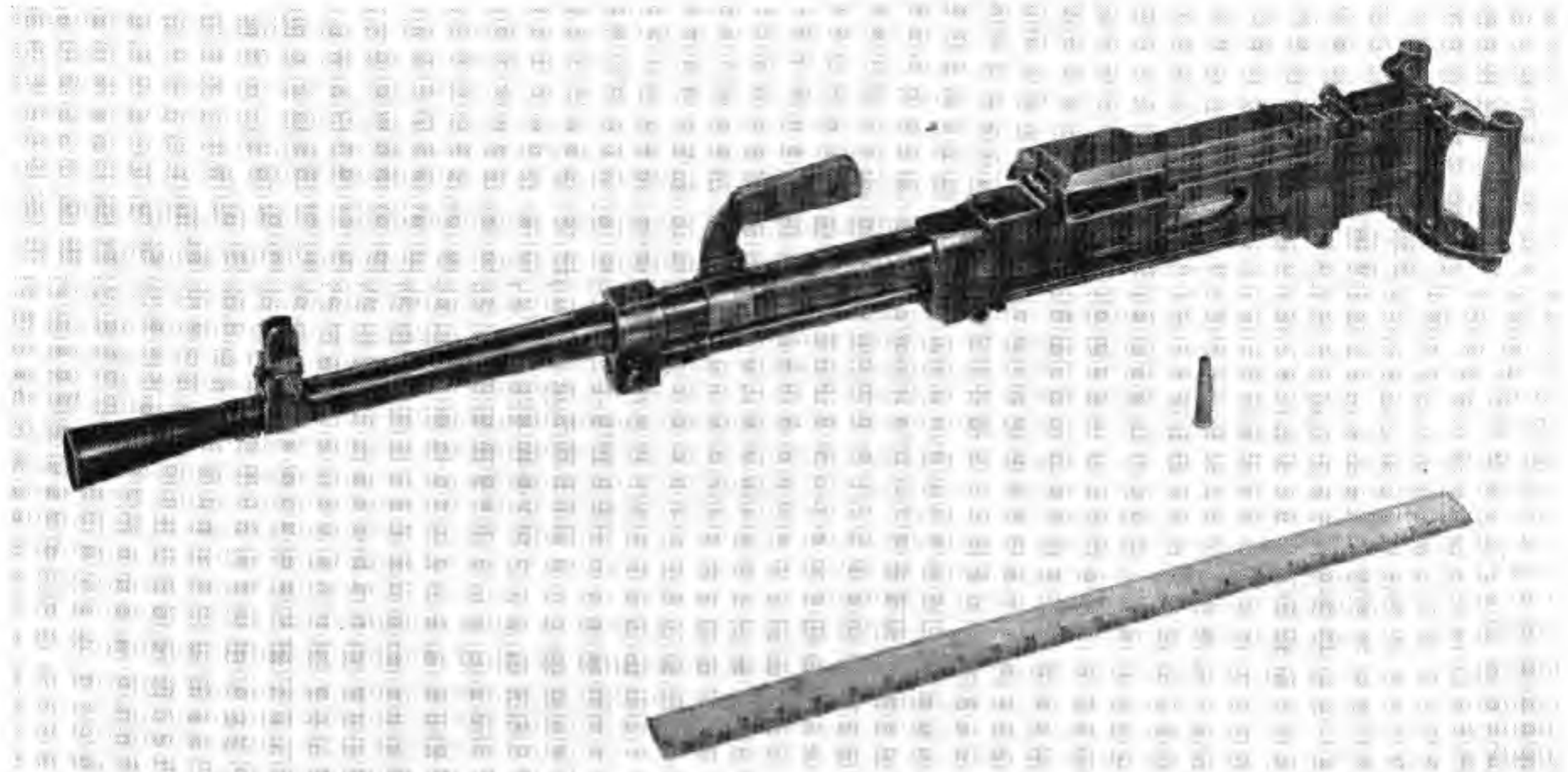

Figure 3–39. SG–43 dismounted from its tripod, left-side view.

Figure 3–40. SG–43 dismounted from its tripod, right-side view.

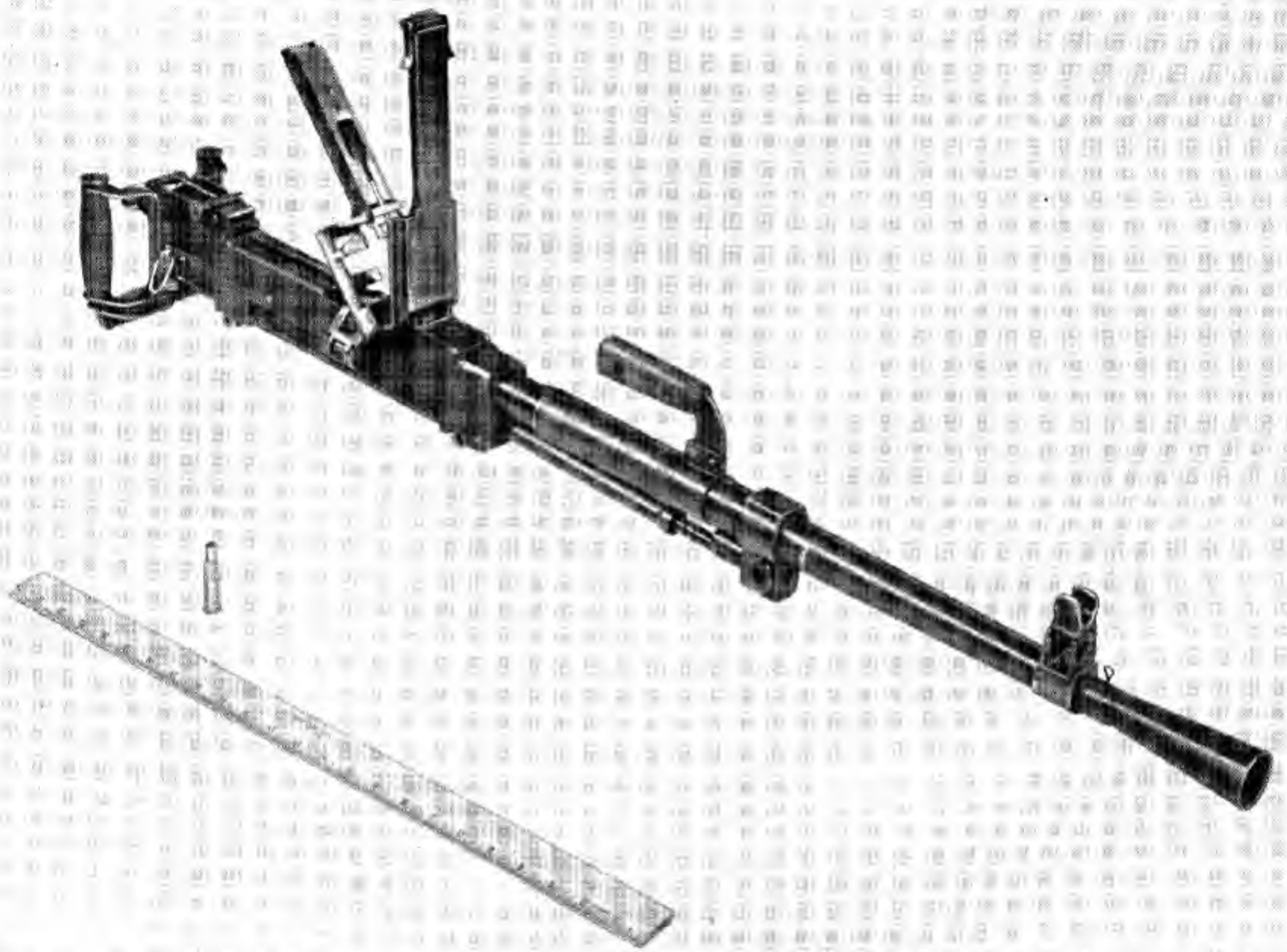

Figure 3-41. Stripping the SG-43. Feed cover opened and two-stage feed hinged up. Barrel has been released and started out of its seat.

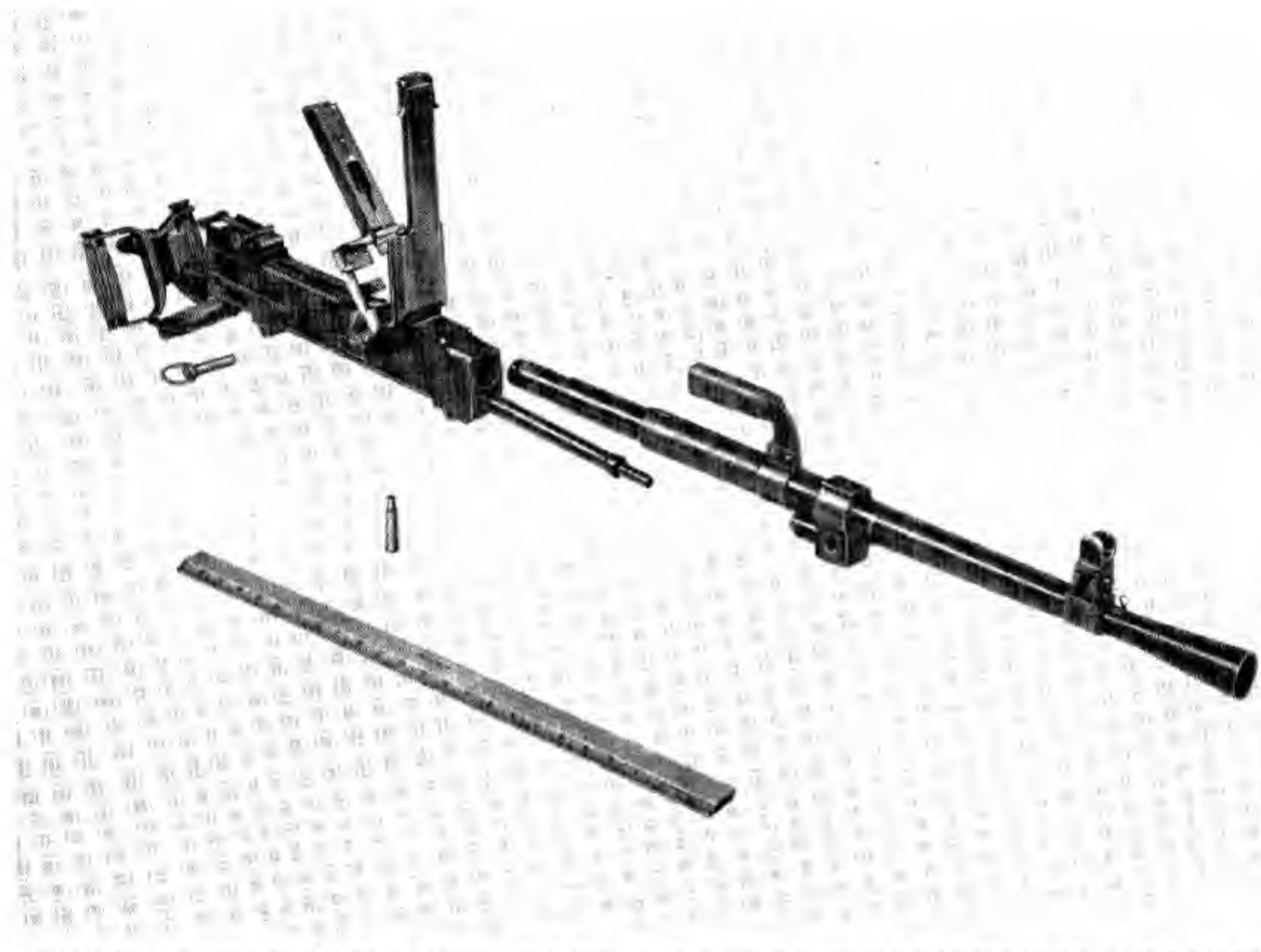

Figure 3-42. Stripping the SG-43, continued. Backplate group released by pulling out retaining pin. Barrel has been removed to the front.

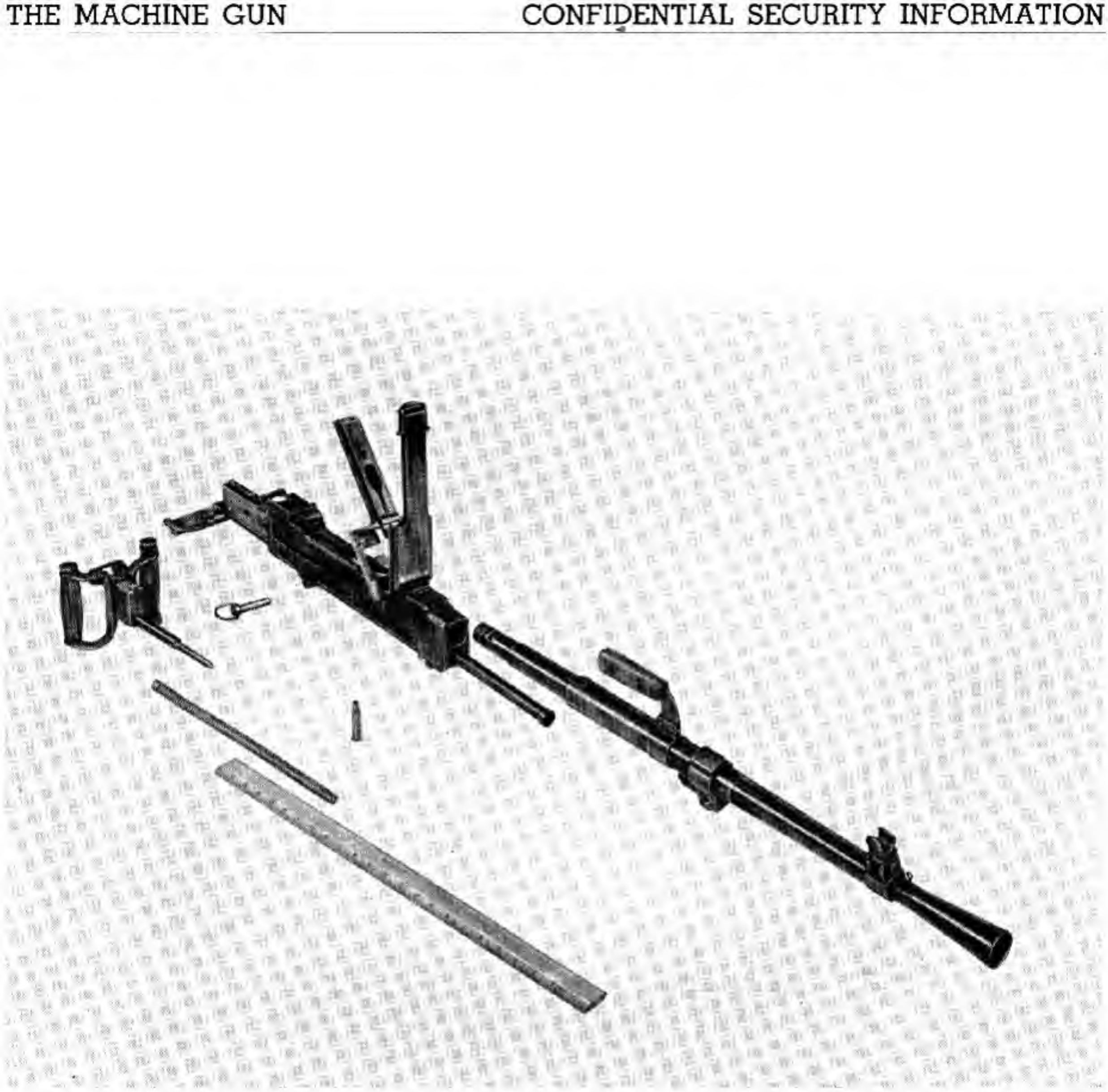

Figure 3–43. Stripping the SG–43, continued. The backplate group and the mainspring have been removed. The recoiling parts have been started out the rear by a pull on the retracting handle.

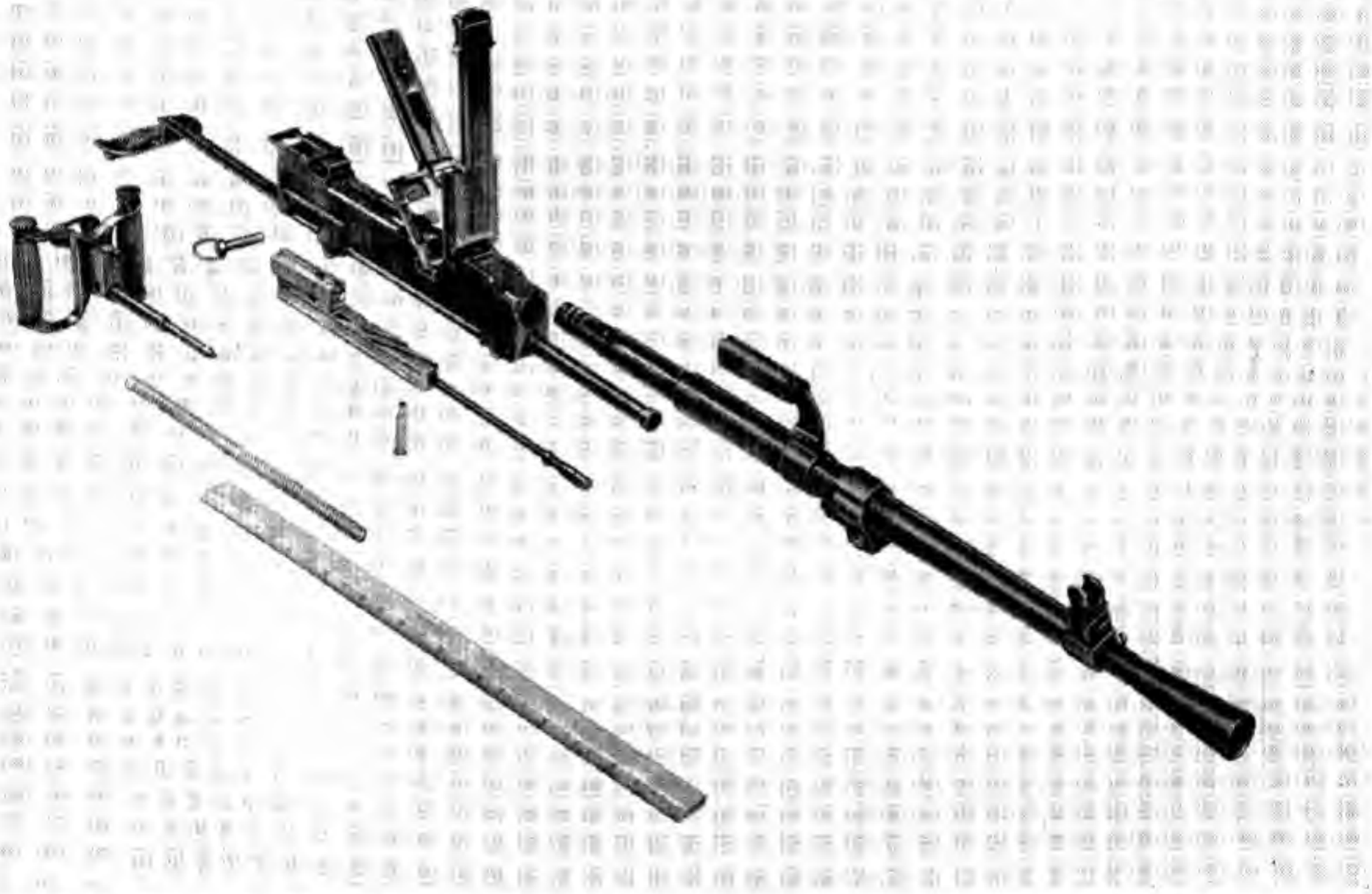

Figure 3-44. Stripping the SG-43, continued. The bolt and the operating slide, with piston attached, have been removed.

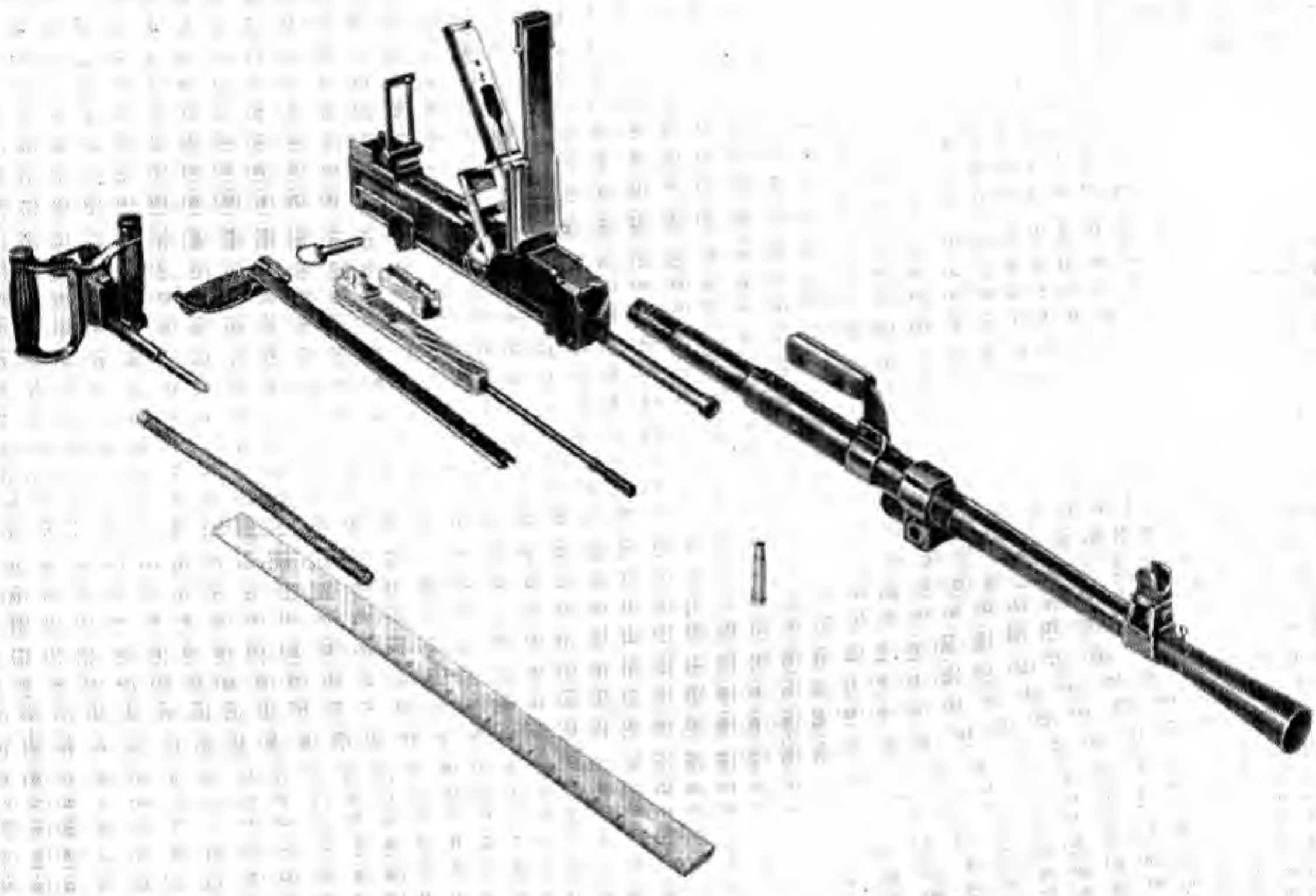

Figure 3-45. Stripping the SG-43, continued. The retracting handle has been removed. The bolt has been separated from the operating slide.

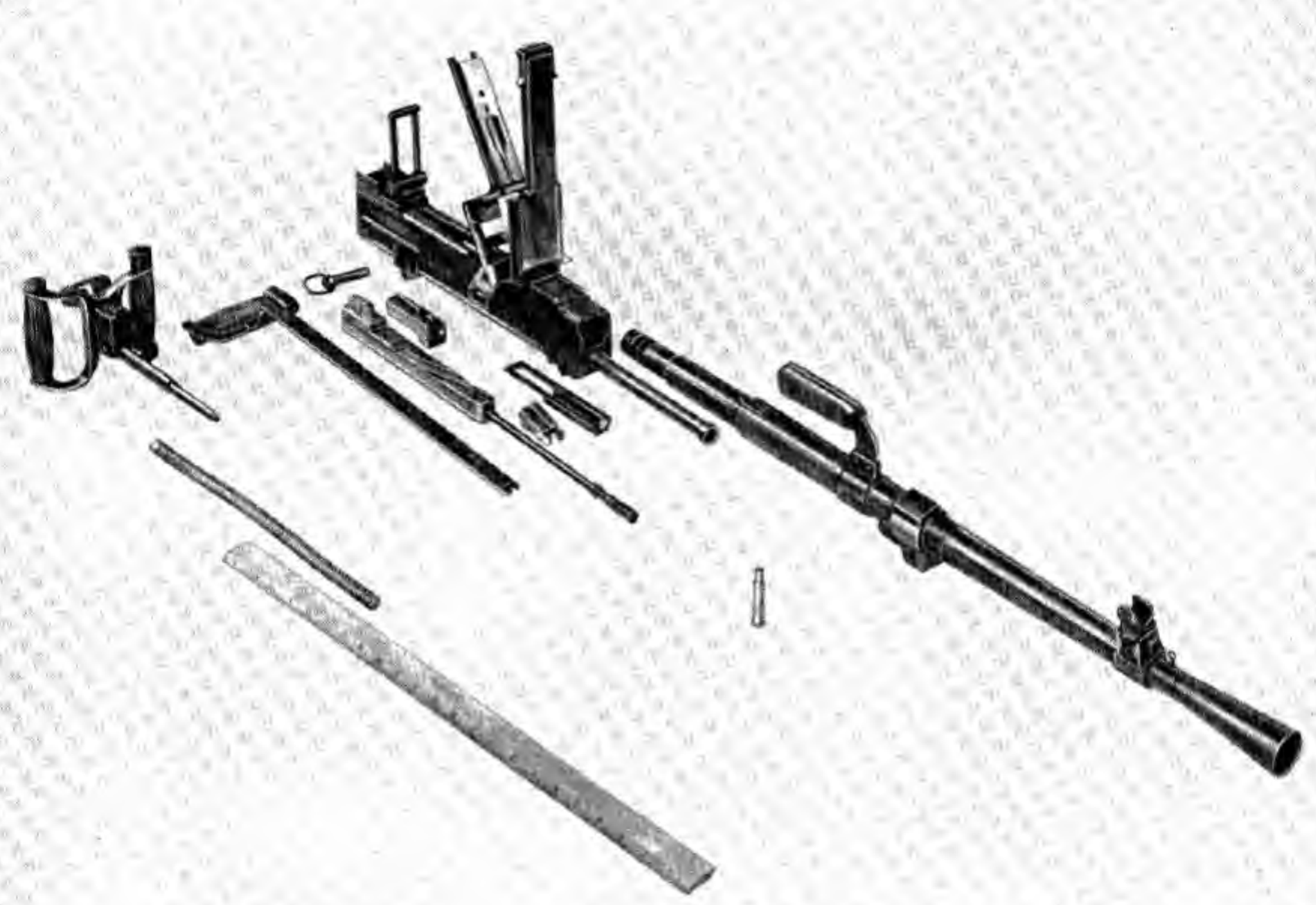

Figure 3–46. The SG–43 field stripped. The parts of the two-stage feed may be seen near the front end of the receiver. The belt feed pawls are still on the gun.

Chapter 4

SHKAS 7.62-mm MACHINE GUNS AND SHVAK AUTOMATIC GUNS

Weapons Included in This Chapter

Shkas Aircraft Machine Guns of the 426 Series*

Designation	Bore diameter	Use	Year of appearance
Machine Gun 426	7.62-mm	Prototype	1932
KM-33	7.62-mm	Flexible	1933
KM-35	7.62-mm	Flexible	1934
	7.62-mm	Wing	1935
KM-36	7.62-mm	Flexible	1936
	7.62-mm	Synchronized	1937
Model 1941	7.62-mm	Wing	1941

*All Shkas machine guns include the number 426 in their markings. By substitution of parts, it is possible to change the tactical employment of the guns marked K. M. (Constructed Model) and Model 1941.

Shvak Automatic Aircraft Guns (Shpitalny-Vladimirov)

Use	Designation	Time of appearance	Caliber
Motor	MP	Early part of World War II.	20-mm
Wing	KP	do	20-mm
Flexible	TP	do	20-mm
Synchronized	SP	do	20-mm
		do	12.7-mm
Prototype		Latter part of World War II.	37-mm

History and Background

The Russians boasted in the early nineteen thirties of an aircraft machine gun of native design that was equal to that of any European power. The appearance of this gun marked the successful conclusion of a development program that had been carried on with the utmost secrecy for a number of years and resulted in the production of a high-speed weapon adapted to aircraft use and suited to both fixed and flexible use on fighter planes.

The finished product was officially given the name of Shkas. The first and second letters stand for the co-inventor, Boris Gabrielovich Shpitalny; the letter K, for the other half of the design team, Irnarh Andrievich Komaritisky; the fourth letter for the Russian word meaning aviation; and the final letter for the Russian symbol for high speed. In other words, the name Shkas means the Shpitalny-Komaritsky Aircraft High-Speed Machine Gun. The weapon was rigidly kept in secret status, but reports as early as 1932 showed that the U. S. S. R. had done much experimenting before accepting the newly designed gun.

The first known model other than the prototype was the KM–33. The translation of "KM" is "constructed (or manufactured) model," and "33" represents the date of origin. Letters were used to designate use: T for flexible, K for wing, S for synchronized. From that time on, all SHKAS guns were marked accordingly.

All progress on the weapon's development was kept in close security. In 1936, Russian reports of its use in the Spanish Civil War referred to it simply as "special machine gun."

Air-firing with the early model Shkas in fighter planes showed good results, but the original construction model made in 1933 was soon eliminated in favor of the production gun "type 426." The latter, however, had only a few minor modifications that were thought necessary to fill more adequately the requirements for aircraft installations.

The KM–33 used a conventional Russian type 6 front sight and a type 5 rear sight. When first

mounted, it was adapted to fit the outmoded Degtyarev mount. The saddle shaped ammunition can was located underneath and held 250 cartridges. A wooden handle piece was used to rotate the feed to index the rounds for loading.

The KM–35, which appeared in 1935, was the standard version. This was followed by the KM–36 which had only a few changes, mostly in mounting and sights. In 1937, a synchronized version appeared. This was definitely an improvement, both in refinement and rate of fire, and it finally backed up with fact a boast made in a May Day speech in the early nineteen thirties to the effect that Russia had an aircraft machine gun of native design which was equal to that of any European country.

A steady production of this superior machine gun allowed the Soviets to put it into use.

The earliest Soviet fighter planes sent to the Spanish front were armed with two Russian-made 7.62-mm guns for synchronized firing through the propeller. A Shkas was mounted as a free gun on a Soviet version of the well-known Scarff ring. Later, two more Shkas guns were added for fixed firing, but they were mounted outside the propeller arc.

These Shkas guns were capable of firing at a speed of 1,800 rounds per minute. When the improved model was issued in 1937, the speed rate was stepped up to a cyclic rate of 2,000 shots per minute when the longest barrel and the largest permissible gas orific were used. As fast as they became available, the improved guns replaced the earlier Shkas models.

Since 1937, the weapon has undergone numerous modifications, most of which are external refinements on such items as barrel lengths, grips, sights, and methods of mounting. Basically, the weapon has remained identical with the first model, as the Russian Air Force believed it had in this machine gun the best of its caliber in existence. The main tactical use of Soviet aircraft, both fighter and bomber, was to support ground troops at a low altitude. A battery of these high-speed machine guns was excellent for strafing.

Soviet policy has always been to retain only proved weapons. This was adhered to so closely during the early part of World War II that it retarded development work on newer weapons. The Shkas, for example, having already been proved in the Spanish Civil War, was relied upon until it became obvious in World War II that all small caliber machine guns were outmoded both for offense and defense. But whenever a rifle-caliber machine gun could be employed to advantage, the Shkas bore the brunt of the work.

For fixed synchronized installation, extra long barrels were supplied. Such barrels caused the muzzle to protrude from the fuselage, making a blast tube unnecessary, and added slightly to the velocity of the bullet. The standard, or short, barrel was used as a free gun.

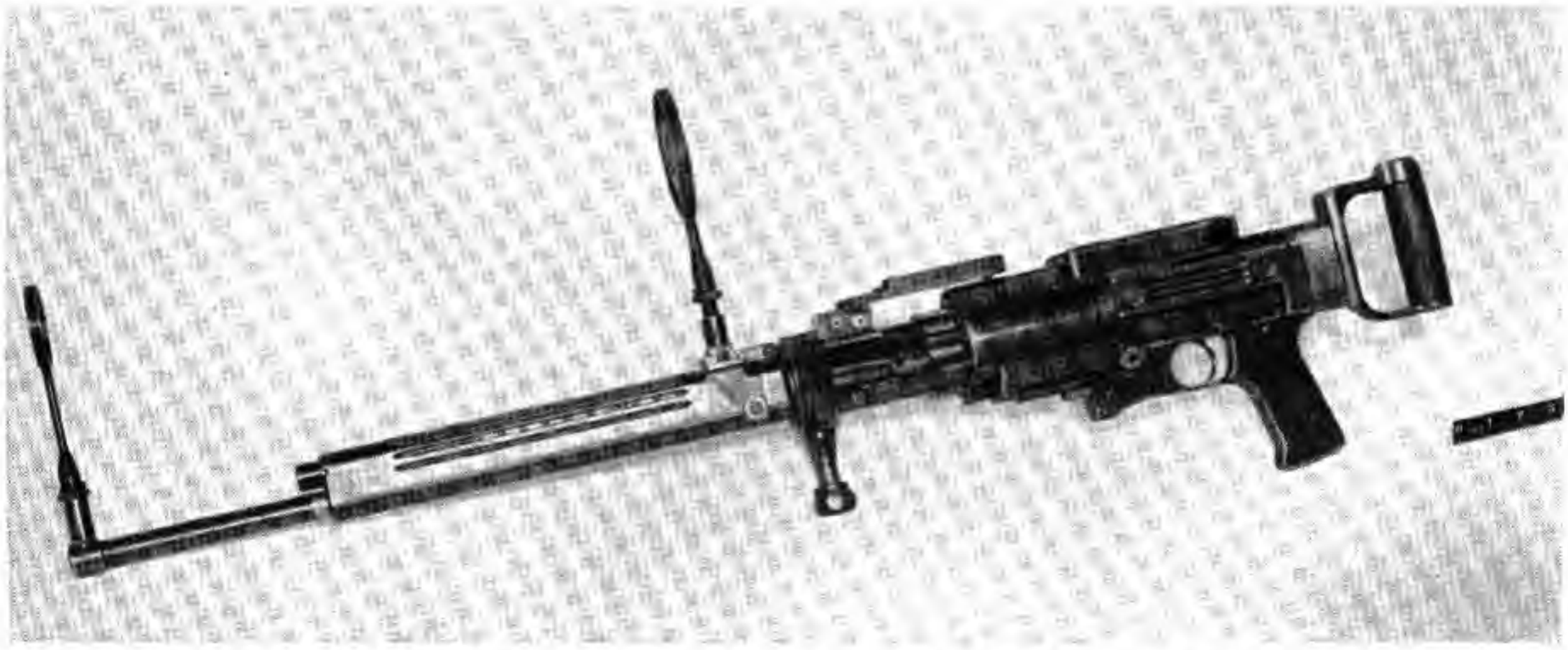

Figure 4–1. 7.62-mm Shkas Flexible Aircraft Machine Gun, left side view.

Figure 4–2. 7.62-mm Shkas Flexible Aircraft Machine Gun, right side view.

The Shkas guns which appeared in Spain were non-synchronized; they were marked with dates as early as 1936. After the German attack of 1941, the existence of other versions was confirmed, as shown in figure 4–3.

The Russians demonstrated great skill in adapting at low cost the best of time-proved principles to their particular needs. Construction was in two phases: a quick, coarse, machining operation on all parts followed by final fitting and assembly on the work

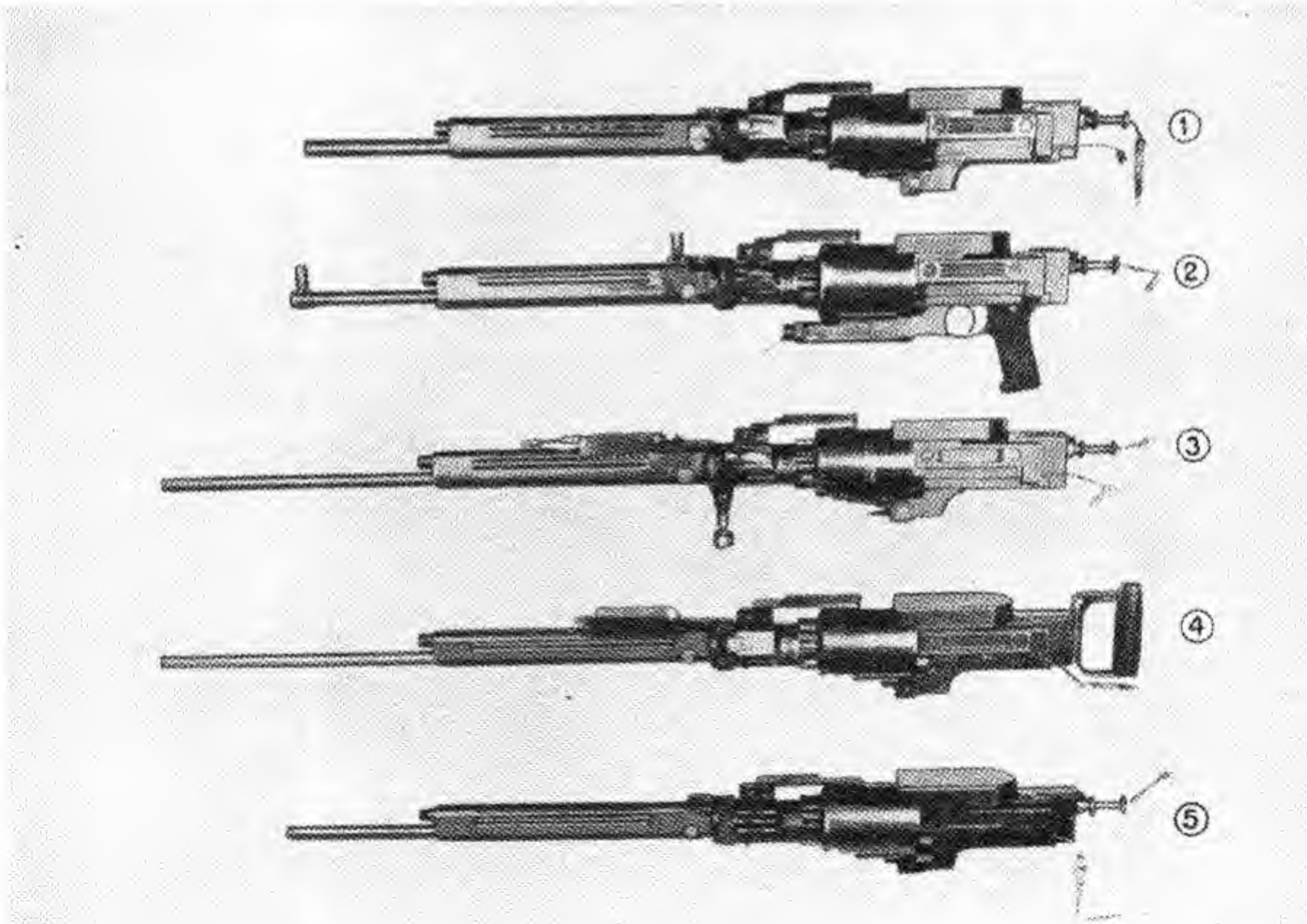

Figure 4–3. Variations of the Shkas: (1) Wing (KM–35; (2) flexible (KM–35, but with mount of KM–33); (3) synchronized, cable retraction (introduced 1937); (4) synchronized, handle retraction; (5) wing, 1941 type.

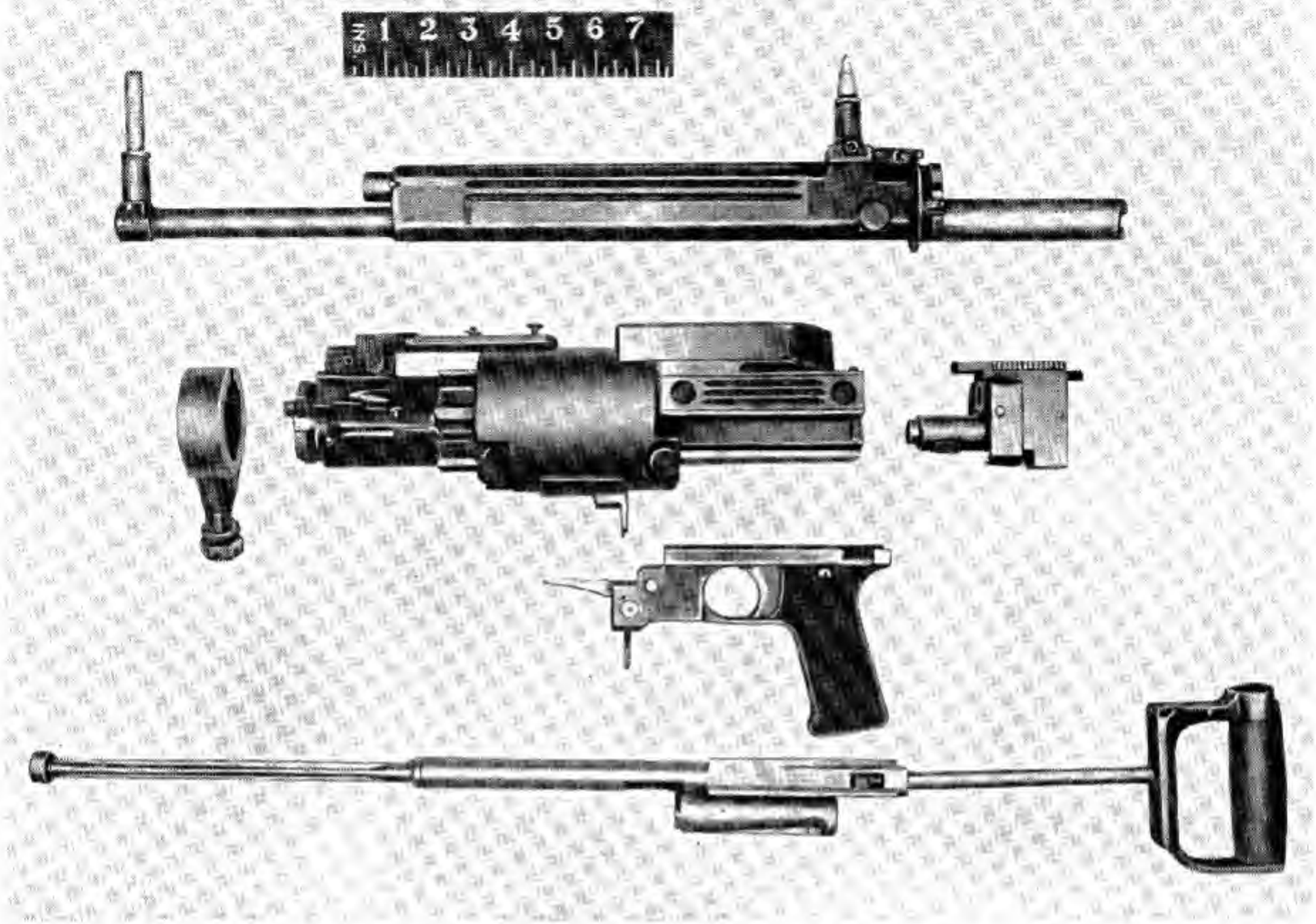

Figure 4–4. 7.62-mm Shkas Flexible Machine Gun, field stripped.

bench. Maximum use was made of semi-skilled labor with a minimum of fine gaged machine tool work. The need for spare parts was reduced by rugged construction of the original components.

For the sake of economy, very low standards of finish were purposely used, resulting in a gun unrefined in appearance and with only a moderate degree of interchangeability. Finish was considered secondary to ease of manufacture. The rough surfaces do not indicate lack of skill or facilities for high-grade production.

The Shkas continues in use today. It has been observed in action in the Korean Operation and is known to be in service in the Air Forces of various Soviet satellites. Figures 4–5 and 4–6 show a fixed version of the Shkas which was captured from the North Koreans by United States Forces.

Shvak Automatic Guns. The Shvak 20-mm automatic cannon, the first of its kind, appeared for the first time during the earliest days of World War II. It was originated by Boris Gabrielovich Shpitalny and S. V. Vladimirov. The gun was brought into being by desperation rather than by forethought. It is a scaled-up version of the 7.62-mm Shkas machine gun. The similarity is confined to the basic principles of the feed mechanism and the operating mechanism. It is noticeable that for the reason of either economy or lack of ideas, the Soviets followed the practice of scaling up rifle caliber weapons.

A 12.7-mm machine gun along the same lines was made at the same time. This gun was dropped, however, because it complicated the ammunition supply. The original Degtyarev cartridge was supplied without the rim; to add a rim to this cartridge

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Figure 4–5. 7.62-mm Shkas Fixed Gun, captured from the Red Forces in Korea. Rear hand grip is a field improvisation. Barrel retaining collar has been removed to show securing lugs.

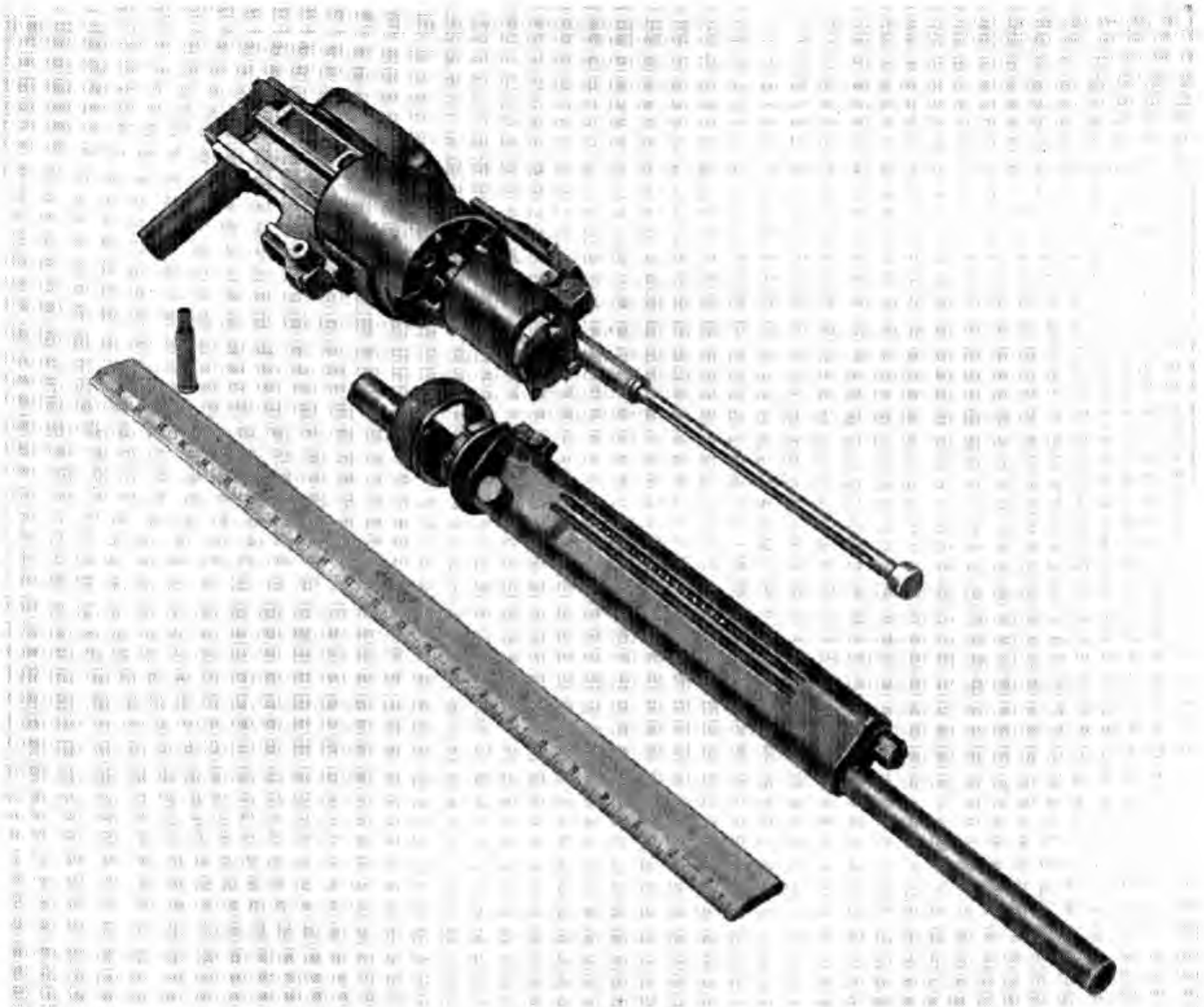


Figure 4-6. 7.62-mm Shkas Fixed Gun, with barrel assembly removed.

at the production stage necessitated considerably more work. (The Shkas design requires rimmed cartridges.)

The 20-mm aircraft cannon used a scaled-up Gatling (Gorloff) cartridge which was practically without taper. However, the Gatling round, which was designed for the manually operated weapon, was about caliber .42.

There were two flexibly mounted versions of the 20-mm type of cannon, one with twin grips and the other with a pistol handle arrangement underneath. Records show that these versions were used extensively in tanks. Shvak guns were also mounted in turrets of aircraft, but with an automatic fire interrupter.

On 20-mm Shvak cannon, the markings are: MP for motor, KP for wing, TP for flexible, and SP for synchronized.

Attempts to scale up the 20-mm to 37-mm size were made but did not prove successful.

SECTION 1. SHKAS 7.62-MM MACHINE GUN

General Data on Later Models

Caliber: 7.62-mm (special aircraft cartridge).
Rate of fire: 1,800–2,000 rounds/minute.
Muzzle velocity: 2,430 feet/second.
Gun length: 27½ inches.
Gun weight: 23 pounds 8 ounces.
System of operation: Gas piston actuated.
System of locking: Propped breech (Berthier). Bolt is forced down in front of lock shoulders.
System of feeding: Belt and revolving cage.
Method of charging: Manual.
Method of cooling: Air.
Rate control: Rate can be varied by gas regulator.
Barrel weight: 2 pounds 10 ounces.
Barrel length: 23½ inches.
Barrel removal: Not a quick change barrel.
Chamber pressure: 44,000 psi.
Bore:
Number of grooves: 4.
Groove depth: 0.0065 inch.
Groove width: 0.158 inch.
Pitch: One turn in 10 inches.
Direction of twist: Right hand.
Form of twist: Concentric.
Chamber: Has flutes to aid extraction.
Method of headspace: Factory established headspace is held secure by barrel lock catch.
Location of feed opening: Bottom center.
Location of ejection opening: Upper left side of receiver; ejects forward.

Description of the KM-33

This gun can be identified easily, as it has a barrel jacket that extends its full length. It is very compact and rugged in construction. Reports claim that the mechanism is practically trouble-free and that unusually high rates of fire of 1,800 rounds per minute have been attained.

The Shkas is belt fed and gas operated. It weighs 25½ pounds and is chambered for the Russian 7.62-mm cartridge with a muzzle velocity of 2,750 feet per second. Although it is admittedly complicated in appearance, it is reliable in every respect.

An interesting departure was made from the heretofore orthodox practice of feeding ammunition to a gun of this caliber. The feed, somewhat resembling a grooved revolver cylinder, is an integral part of the gun, and the cartridges remain axial throughout the entire operation.

The cylindrical feed cage is rotated by an arm that engages a slot in the gas piston. A helical groove in the drum arrangement withdraws the cartridges from the metal disintegrating link belt as it moves through the feedway by engaging their rims and gradually camming the cartridges rearward. The freed cartridges are then presented at the bottom of the receiver for chambering by final rotation.

This circular type of feed holds ten rounds. Several phases are required to completely delink a round and roll it up into position for being shoved into the chamber. A small folding handle held on the top side is used to rotate the feed drum when filling with cartridges.

Camming the round slowly out of the belt with this type of feeder causes practically no drag when the weapon is fired at high speed. It has belt pull enough to take care of practically any length belt desired.

The ejection system is a novel application of the early Maxim method of pushing the empty cases

forward out of the receiver instead of down or to the side. The ejector opening, located in the top left side of the receiver, is in the form of a tube.

The ejector consists of a cam-operated lever with a projecting arm that sweeps the empty cartridge case off the bolt face and holds it so that on counter-recoil of the piston it will strike the rim of the empty case, driving it forward out of the tubular opening. Many advantages can be found in this type of ejection.

The grip used for flexible firing also serves as a charging handle merely by pushing in on the release button at the top of the grip and pulling it all the way to the rear. When a pistol grip handle is used, a small charging handle is located in the rear.

The center section of the barrel is made up of several aluminum cooling fins to help dissipate the heat. No provision is made for single shots, there being only two choices on the selector switch: AUTOMATIC FIRE and SAFE. The firing pin is not attached to the gas piston, in contrast to other gas-operated firing mechanisms, but is pinned in the bolt body and allowed to float. Not being spring-loaded, the round is cammed rearward as the empty cartridge case is swept from the bolt face. The buffer consists of two heavy springs, the smaller one nested in the larger.

The normal amount of ammunition carried in fixed mountings is 750 rounds, but in some turret installations the container holds as many as 1,000 to 1,500 cartridges. This fact speaks eloquently for the abnormal belt pull of the weapon with its slow-camming revolving-type feed. The Russian Air Force nicknamed this circular arrangement the "bird-cage" feed. It is an adaptation of a system first used by the Polish designer, Gabriel Szakats.

The unlocking action, by which all machine guns are classified, is that of the much-copied Berthier. In this system, the piston driven to the rear lifts and unlocks the bolt, carrying it to the buffer. This procedure is followed by counter-recoil, at the end of which the bolt is locked. The function of unlocking is then repeated to begin another cycle.

Thus the Shkas is an innovation based on the features of the Maxim (ejection and buffer), the Szakats (rotating feed), and the Berthier (piston-actuated, propped breech, locking). Hardening processes are rarely used in the construction of this weapon. Rough tool marks are seen on nearly all components, most of them bearing evidence of hand filing. The most accessible surfaces are turned and hand finished; where machine finishes are interrupted, the projections or flats are finally shaped by hand filing. Sharp edges are unevenly chamfered,

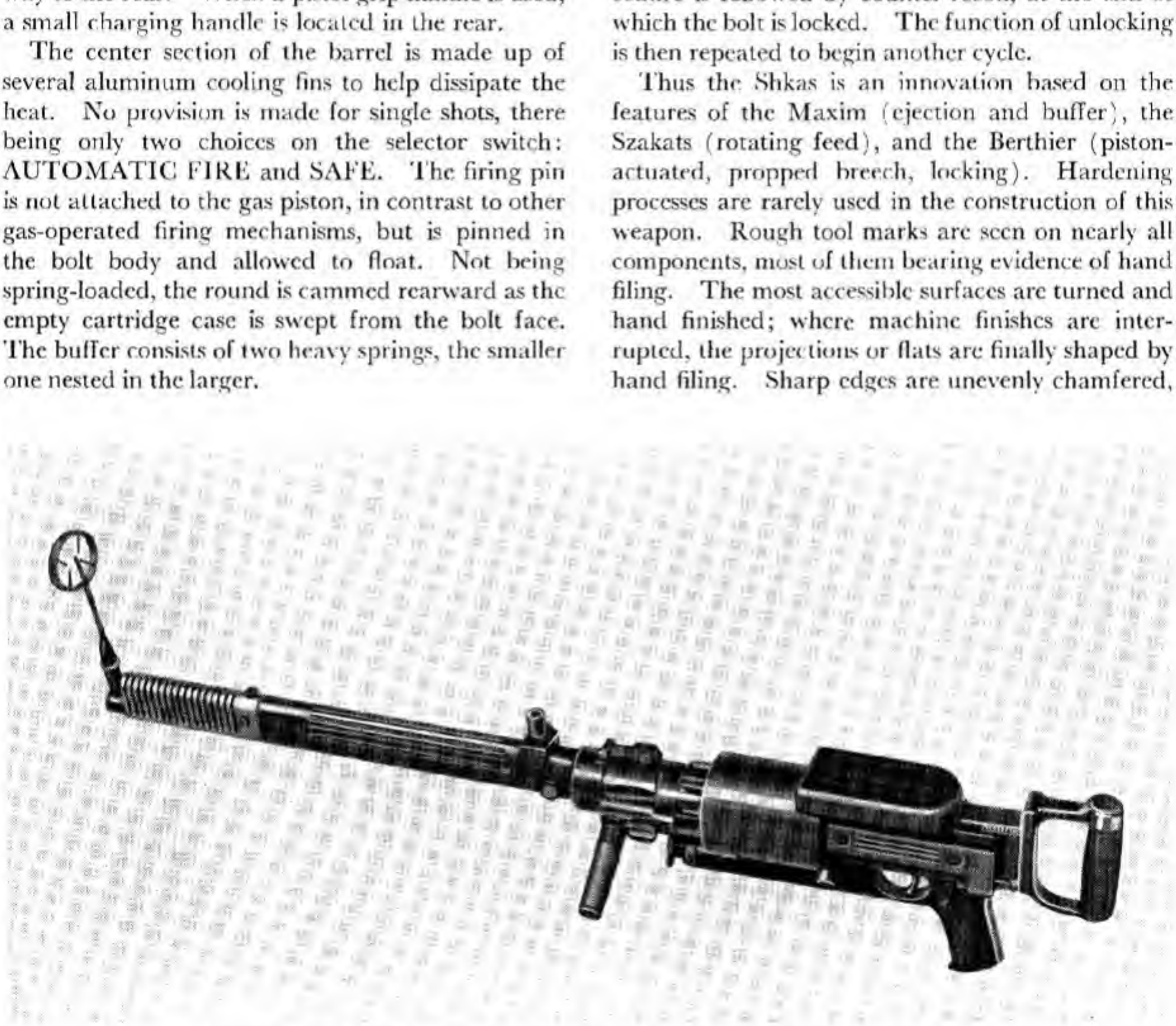


Figure 4-7.. 7.62-mm KM-33, an early version of the Shkas Aircraft Machine Gun.

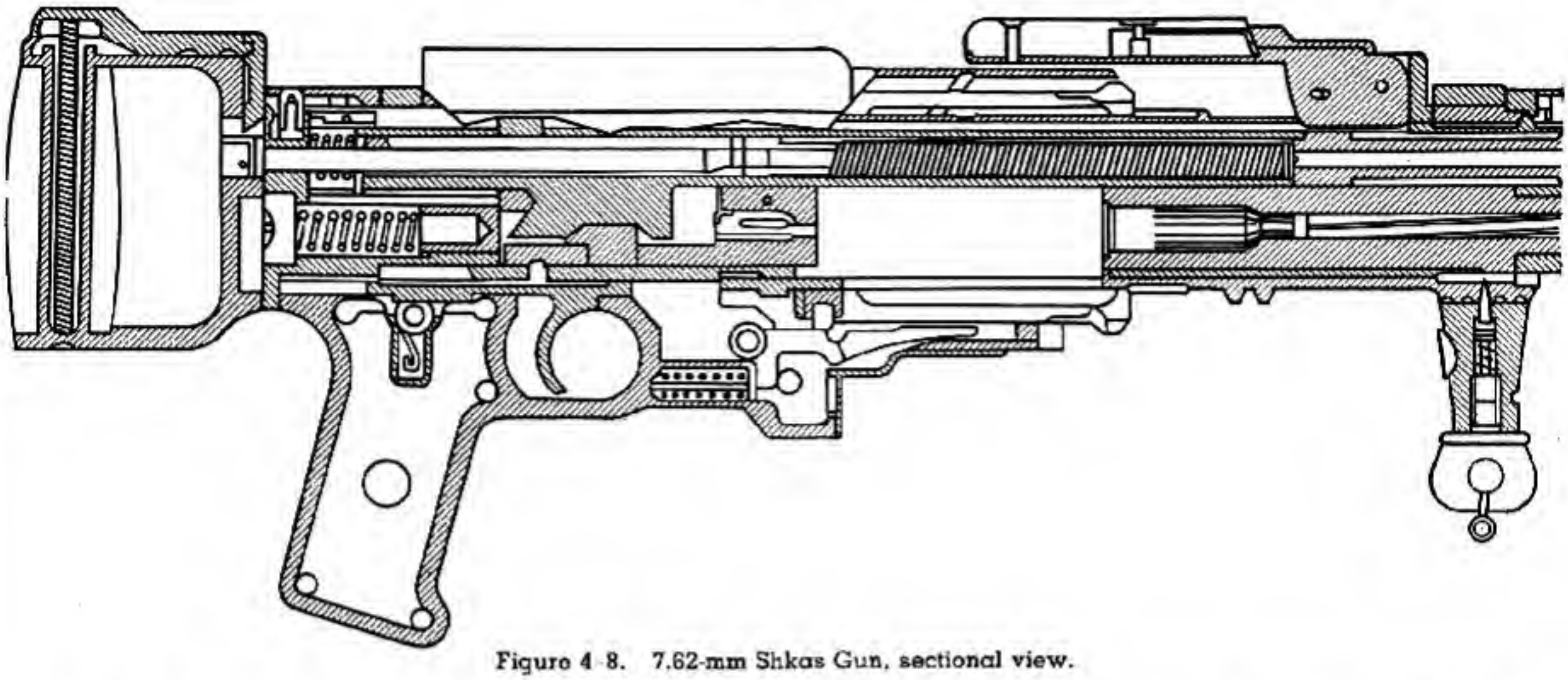


Figure 4-8. 7.62-mm Shkas Gun, sectional view.

also by hand; and the crude uneven radii shown in cross-section drawings suggest that components are not held to close tolerances by gages.

While the gun is known for its unusually high rate of fire, it does have provision for regulating the cyclic rate. This is done by changing the position of the holes in the gas regulator, which comes with holes of three different sizes, $\frac{1}{12}$-inch, $\frac{1}{10}$-inch, and $\frac{1}{8}$-inch. The smaller the orifice used, the more moderate is the rate of fire obtained.

No flash eliminator is attached to this gun, contrary to the custom in practically all Russian machine guns. However, some barrel ends have been found to be slotted, and in some instances they are threaded. It is assumed that a flash eliminator is fitted to some of the later models.

Cycle of Operation

To fire the Shkas, the gunner introduces the loaded belt into the first flute of the circular feeder and then raises the folded handle on top of the receiver, pulling it down and to the left as far as it will go.

The rounds are moved around by a ratchet movement and cammed out of the belt until ten are in the cage and the first cartridge indexed.

The button on top of the hand grip is pushed in and the bolt assembly is pulled back until the rear sear engages the gas piston, holding the operational parts in the cocked position.

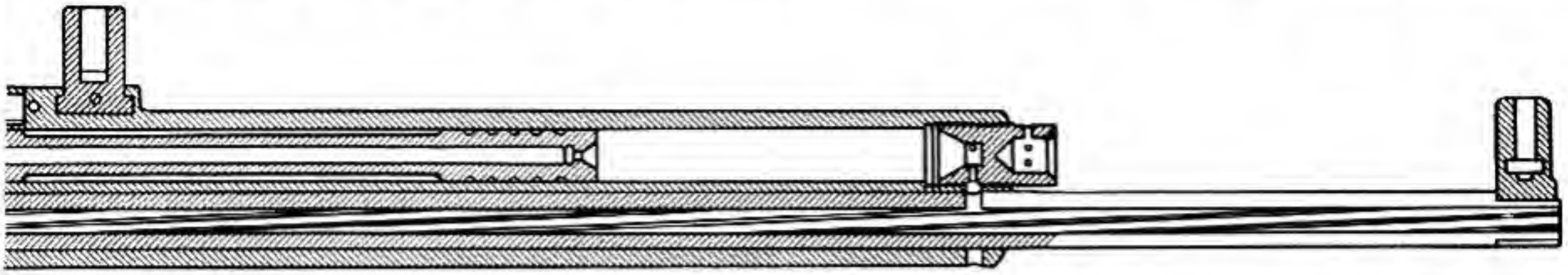
The grip handle is then shoved forward until its securing latch clicks into position. The weapon is now charged and ready to fire.

When the trigger is pulled, the gas piston and bolt fly forward. Engagement of the stud on the gas piston with a groove in the circular feeder causes it to rotate half the indexing distance and to kick a cartridge into the guideway for chambering.

As the bolt goes into battery, it first brings the locking lug on its aft end in alignment with its recess in the barrel extension. The continued movement of the piston pushes the lug down into the locked position out of the way of the piston projection. Further travel drives the floating firing pin into the primer of the cartridge.

Once the bullet has passed the port in the barrel, gas enters the cylinder that houses the piston and the latter is shoved to the rear. For the first half inch, the barrel and bolt remain locked together. The locking lug on the piston then cams the bolt lug up and out of engagement, and the assembly of bolt and piston moves rearward with the extractor holding the empty cartridge case to the bolt face.

After the assembly has moved a distance slightly greater than the overall length of the cartridge, a cam-actuated lever sweeps the cartridge from the face of the bolt and holds it in the up position. The projection of the gas piston, upon engagement with the feed groove, turns the circular feed half of the indexing distance between rounds, and the operating assembly recoils until it hits the heavy spring-



loaded buffer which deflects it forward into counter-recoil.

As the counter-recoiling parts pass the rear of the feed cage, the empty cartridge case is struck by a shoulder of the gas piston and driven forward out of the upper left side of the receiver. The advancing bolt then begins to chamber the round. The rotating feed has previously been positioned, and the final movement to battery of the gas piston locks the bolt and fires the cartridge to repeat the cycle.

Disassembly by Groups

To disassemble the Shkas, the following procedure is adhered to.

1. Push the ammunition follower release lever inward, and turn in a counterclockwise direction until it is approximately at right angles with the barrel of the gun.

2. Depress the cocking handle catch, and pull the cocking handle to the rear.

3. Depress the backplate lock plunger, and slide the backplate lock to the rear; then unscrew the backplate lock groove (right hand thread).

4. Turn the handle 180°, and remove.

5. Turn the backplate 45° in a clockwise direction, and remove.

6. Slide the trigger housing group to the rear and off the receiver.

7. Replace the cocking handle.

8. Slide the plate on the right side of receiver to the rear.

9. Turn the sear release lever 90° in a counterclockwise direction.

10. With the gun lying on its right side, push the cocking handle approximately half-way home. This motion releases the ejector bar pivot from the operating groups. Then pull the operating group from the receiver.

11. Repeat step 4.

12. Lift the bolt from the gas piston rod assembly.

13. Drive up the firing pin with the retainer pin; remove the firing pin.

14. Remove the cartridge stop pin; remove the cartridge stop.

Assembly by Groups

To assemble the Shkas, reverse the disassembly procedure just given.

Detailed Disassembly

For detailed stripping, use the following procedure.

1. Lift the trigger and the trigger bar from the frame.

2. Turn the safety lever 90 degrees in a counterclockwise direction from the firing position; drive it out from left to right, being careful to catch the safety lever plunger and the spring.

3. Turn the ammunition follower release lever straight up and press it out from left to right, being careful to catch the ammunition follower. Release the lever plunger and spring, at the same time holding the follower down to prevent the follower spring from jumping out.

4. Raise the follower slowly until the follower spring is released, and then remove the follower spring.

5. Drive out the ammunition follower pin and remove the ammunition follower.

6. Slide the ammunition rack pole cover on top of the receiver to the rear, and lift it off.

7. Lift off the ammunition rack pole assembly.

8. Pull off the ammunition rack pole, plunger cam, and roller pin from the left side.

9. Remove the ammunition rack pole roller.

10. Remove the ammunition rack pole plunger cam by driving it out.

11. Remove the ammunition rack pole plunger cam and the roller link.

12. Remove the ammunition rack pole plunger release lever pin; remove the lever, being careful to

catch the spring and also to keep the plunger from jumping out under pressure of the plunger spring.

13. Slide out the ammunition rack pole plunger and the spring.

14. Release the barrel lock catch by sliding the small knurled knob and lifting.

15. Turn the barrel lock 45 degrees in a counterclockwise direction, and slide the barrel and gas cylinder group forward.

16. Drive out the front sight pin, and slide the front sight pin off the front end of the barrel.

17. Slide the barrel out to the rear.

18. Drive out the gas regulator pin, and unscrew the gas regulator (right hand thread).

19. Drive out the barrel lock catch pin, and remove the barrel lock catch, being careful to catch the spring.

20. Remove the guide by pulling the catch rearward and lifting, then slide the collar off the front of the receiver.

21. Remove the ammunition rack by sliding off the front of the receiver.

22. Remove the ammunition rack bushing lock screw (right hand thread); slide the ammunition rack bushing off the front of the receiver, being careful to catch the cartridge case guide spring.

23. Remove the cartridge case guide spring.

24. Slide the ejector bar pivot to the rear, and lift out the ejector bar group.

25. Slide the ejector bar pivot off the ejector bar.

NOTE. The searing mechanism cannot be disassembled in the field.

Assembly of Components

Reverse the procedures just given.

The applied safety on this weapon is a safety lever located on the right side of the trigger frame, which, when rotated until the lever points to the front of the gun, prevents the trigger from being pulled to the rear. The only mechanical safety is the camming down of the bolt just as it reaches the forward position, thereby locking the bolt at the instant of firing and not allowing the lug on the gas piston rod extension to hit the rear end of the firing pin.

SECTION 2. SHVAK 20-MM AUTOMATIC GUNS (SHPITALNY-VLADIMIROV)

General Data for Shvak 20-mm Automatic Gun

Caliber: 20-mm.
Rate of fire: 700–750 rounds/minute.
Muzzle velocity: 2649 feet/second.
Gun length: 83.5 inches, 69.3 inches.[1]
Gun height: 6.09 inches.
Gun width: 6.06 inches.
Gun weight: 149.6 pounds, 88 pounds.[1]
System of operation: Gas.
System of locking: Rear of bolt rises against locking shoulders in receiver.
System of feeding: Belt; cage holds 11 rounds.
Method of charging: Mechanical on earlier models, pneumatic on later models.
Method of cooling: Air.
Rate control: Automatic only.
Barrel weight: 21 pounds.
Barrel length: 64.9 inches.
Barrel removal: Quick change.
Chamber pressure: 42,660 psi.
Bore:
  Number of grooves: 8.
  Groove depth: 0.013 inch.
  Groove width: 0.20 inch.
  Pitch: 1 turn in 20 inches.
  Direction of twist: Right hand.
  Form of twist: Constant.
Method of headspace: Factory established headspace is held secure by barrel lock catch.
Location of feed opening: Top of body (Revolving type).
Location of ejection opening: Bottom-right side (a tube arrangement can be adjusted so that expended case can be ejected either forward or to the rear).

NOTE 1. These numbers may represent differences between the long- and the short-barrel weapons.

Description of the Shvak 20-mm Automatic Gun

The weapon has a rough exterior, since no unnecessary finish was applied to improve external appearance. However, in comparison with the rifle caliber Shkas, the external appearance is very clean. In relation to its power, the gun is very light and extremely compact.

One of the outstanding features of this weapon is the method of solving blast tube difficulties, a troublesome problem in all installations of aircraft cannon in fighter aircraft. The Soviets' simple solution was to thread the end of their standard barrel and then screw on for whatever length was needed a heavy piece of tubing, the bore diameter of which was slightly greater than that of the rotating band of the projectile. This arrangement allowed the blast and gas to leak around the projectile before it cleared the tube, not only reducing the blast effect of the weapon but also by its added length safely leading the blast and projectile past portions of the plane that would otherwise have been injured.

Gas operation presented the Soviets with a convenient method of obtaining a high rate of fire. The simple construction and generous working tolerances permit reliable performance in spite of the lack of final finishing by skilled workmen.

From the economic standpoint, worn-out guns can be rejuvenated to operational status simply by taking advantage of the wide ratio allowed by the noncritical measurements. Accordingly, worn parts can be reproduced and replaced by semiskilled personnel. Complete change of components is necessary only in connection with major inspection and overhaul.

The methods used in construction are similar to those used in previous weapons in that the Soviet

Figure 4–9. 20-mm Shvak Machine Cannon, arranged for forward ejection.

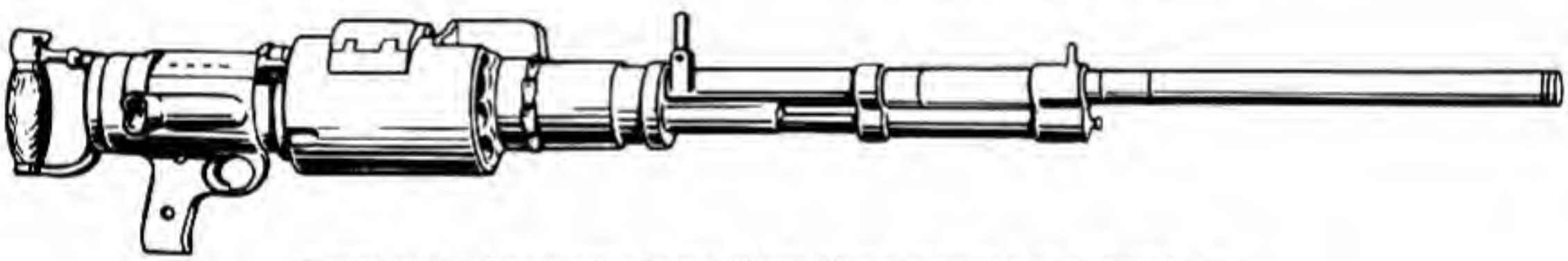


Figure 4–10. One version of the 20-mm Shvak, mounted as a flexible gun.

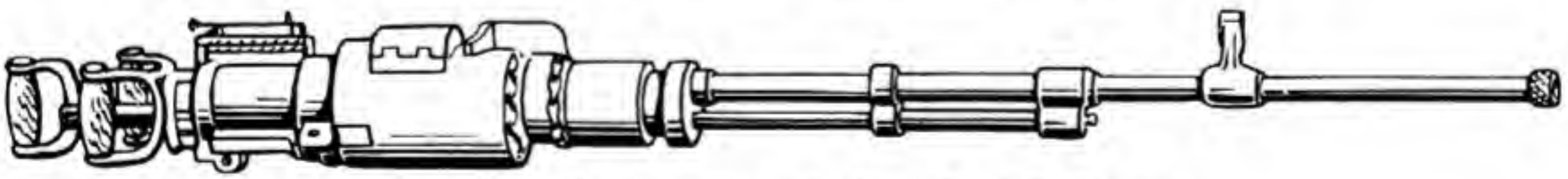


Figure 4–11. Another version of the 20-mm Shvak flexible gun.

Figure 4–12. The 12-mm version of the Shvak. A rare gun requiring a special cartridge case.

practice of using soft materials is predominant. This form of manufacture is a disadvantage in some respects, but it is well suited when no great antishock requirement is demanded of certain component parts. This practice is advantageous in large caliber weapons (1) for obtaining a high rate of fire, especially when a short life expectancy is acceptable, and (2) for instituting a further safety margin against failure by breakage. These parts were not heat treated; they, accordingly, deform and bend well in advance of fracture.

The composition of individual components is not suitable for mass production in accordance with American standards: since final completion is by

Figure 4-13. The "bird cage" of the Shvak feed as seen from the rear. This cage is the moving device for the belted rounds, each pair of teeth engaging a cartridge.

filing down, considerable turning and milling in the earlier stages is required. Sheet metal pressings are used for some of the exterior fittings. This is the first instance of this type of construction noticed in Soviet aircraft weapons. This fact is not considered significant, however, as it has no bearing on the general design.

Even though the 20-mm Shvak is relatively difficult to produce, documentary evidence indicates that the practical results achieved are generally good and the performance only slightly inferior to British and American guns of the same caliber. This weapon has a range comparable to our M3 cannon, although their short barrel version is 16 pounds lighter.

Mounting the gas cylinder below the barrel is perhaps the most noticeable difference between the Shvak and the Shkas. This feature gives the weapon a more compact assembly, thereby eliminating installation problems. The weapon is gas operated, using adjustable orifices. The feed takes place on the right-hand side and is not reversible. A disintegrating metal belt is pulled into the feedway by a cylindrical cage which rotates only in a counterclockwise direction.

Rounds remain coaxial with the barrel throughout the complete operation; on interruption of the fire, the breech is closed and the cartridge stays in the chamber. The weapon has no applied safety device. On engine mounted installations, this weapon is normally arranged to fire through the propeller hub.

A manually operated toggle provides the means to recock the weapon in the event of gun stoppage. The system, besides being crude, requires considerable physical effort by the operator. If judged by present day American standards it would be considered obsolete.

The motion of the feed cage and the feed from it is a decided improvement over the Shkas. However, the feed system in both weapons ensures the steadiest possible flow of ammunition: as the cage

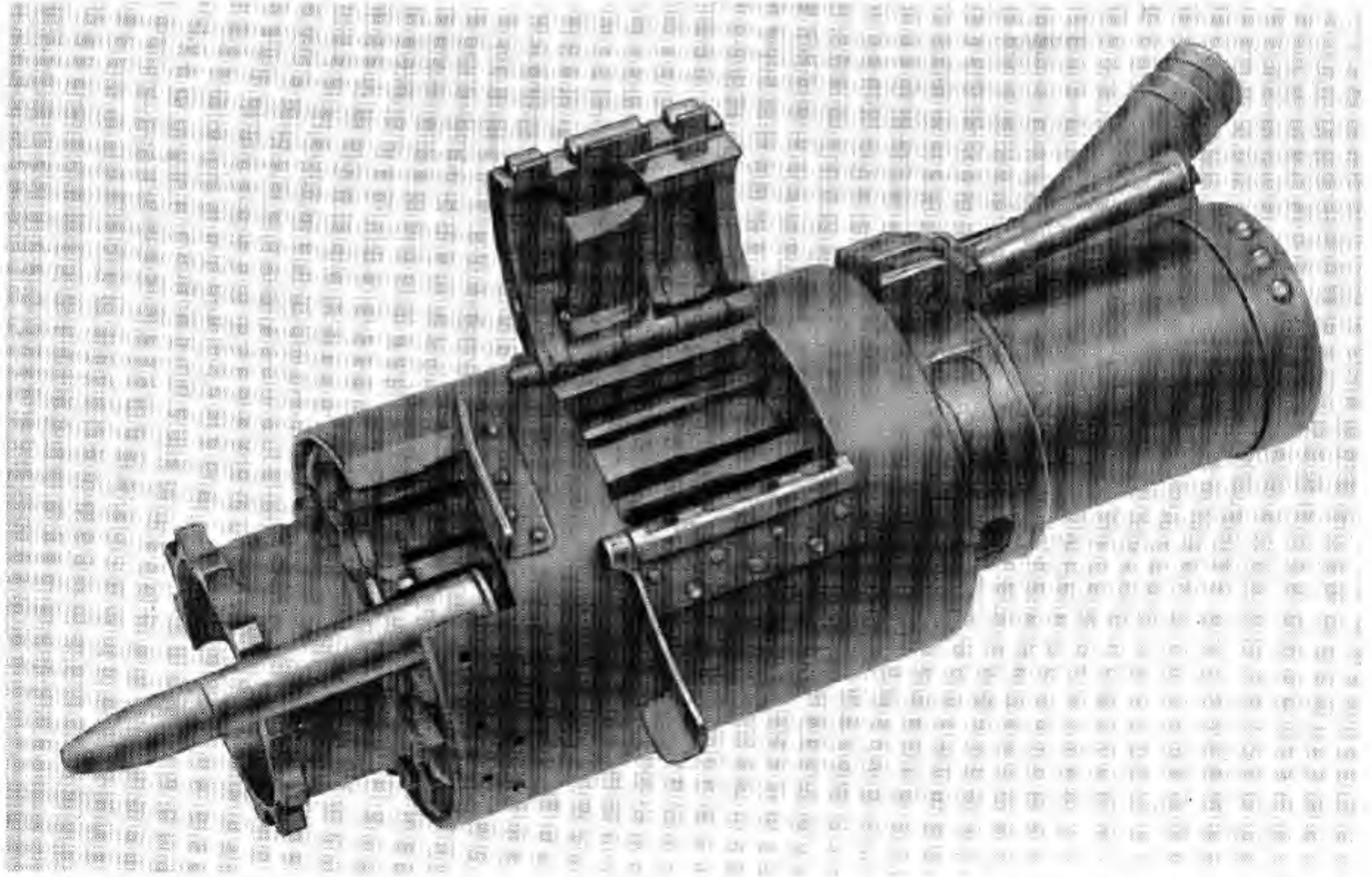


Figure 4-14. Rotary feed of the Shvak, showing a round at the position where the belt enters the feed. The rim of the cartridge is about to engage the groove (not visible) which will cam it to the rear.

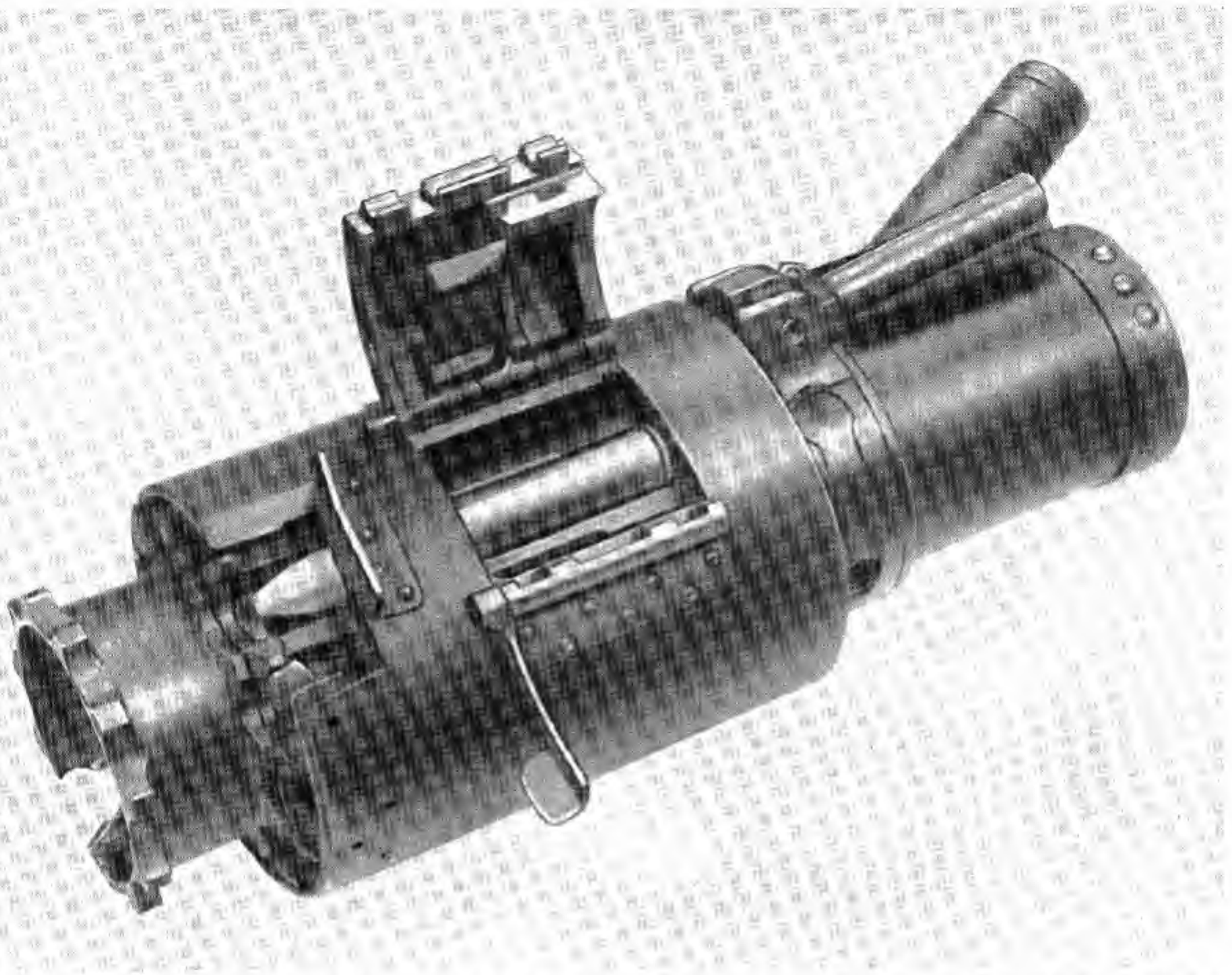


Figure 4 15. Rotary feed of the Shvak, showing the position of the round when it completes its circuit around the rotary feed. The cover is open to show the spring-loaded arm, which forces the cartridge through the feed mouth into the path of bolt travel. The end of the helical groove which withdraws cartridges is visible below the right of the cover hinge.

always rotates evenly in the same direction, the absence of belt lurch guarantees the accurate presentation of the round, free from variables associated with other types of feeds in which each round is forced from its own link.

The feed cage when fully loaded holds eleven rounds, and is rotated by pawls operated by a feed slide attached to the recoiling portion. Helical grooves in inner and outer fixed drums cause rounds to enter the cage which rotates between them.

The ejection tube is situated on the lower right side of the gun, inside the body. The ejector consists of a cam-operated bar fastened to an arm which sweeps the cartridge case off the face of the bolt. This action forces the firing pin back at the same time. The main spring is of the multiwire strand type. The barrel locking piece is placed in position; with a screw driver in the slot in the top of the splines, the piece is raised and rotated for alignment.

The system of operation is best described as gas piston actuated and is very similar to the action of the well known Berthier gun, having also incorporated the Berthier type of gas regulator which slides into the mouth of the gas cylinder and is held in position by a cotter pin.

The gas regulator has four holes marked 3.5, 4, 4.5, and 6, representing the sizes in millimeters. The gas port in the barrel is 7 mm in diameter; it is situated on the under side, about half way between the muzzle and breech.

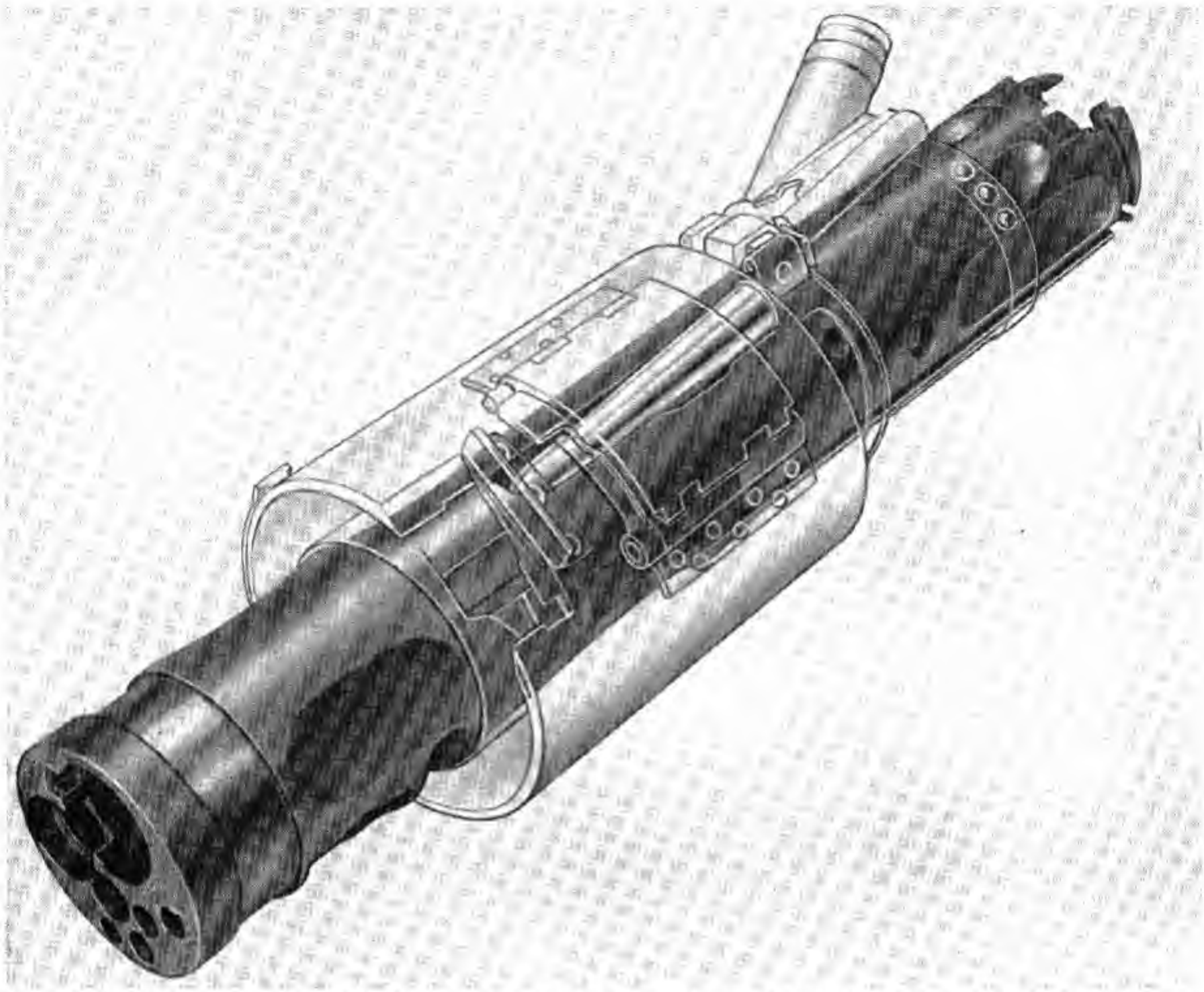


Figure 4-16. Phantom view of Shvak feed with cage removed, showing the round being forced through the feed mouth in the receiver.

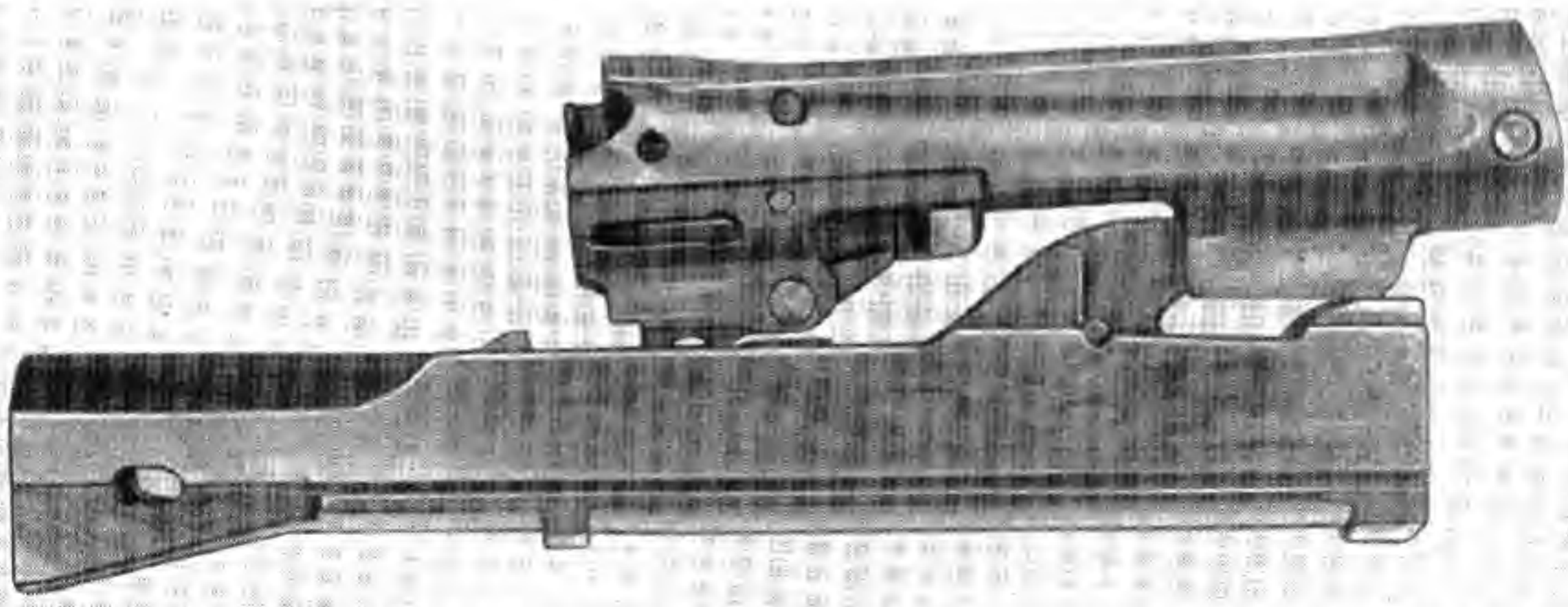


Figure 4-17. Locking action of the Shvak, showing how the rear of the bolt is cammed up in front of the locking shoulders (not shown).

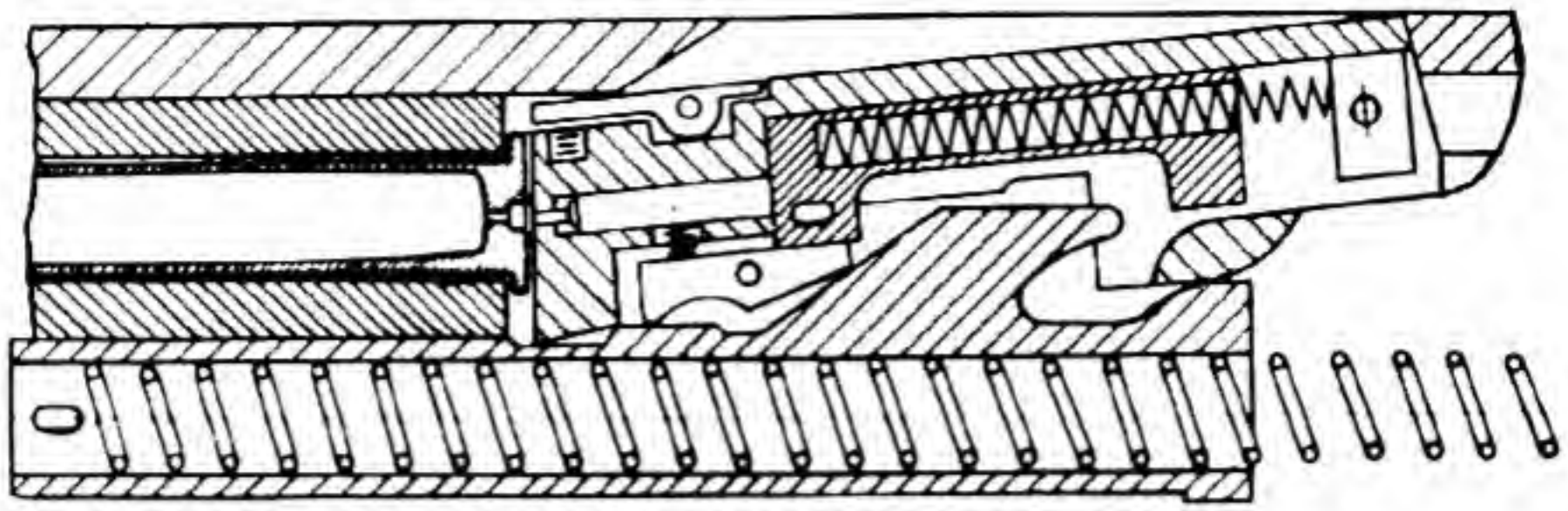


Figure 4–18. Locking action of the Shvak Cannon. Top to bottom: Ignition; commence unlocking; unlocked; reloaded, locked and cocked.

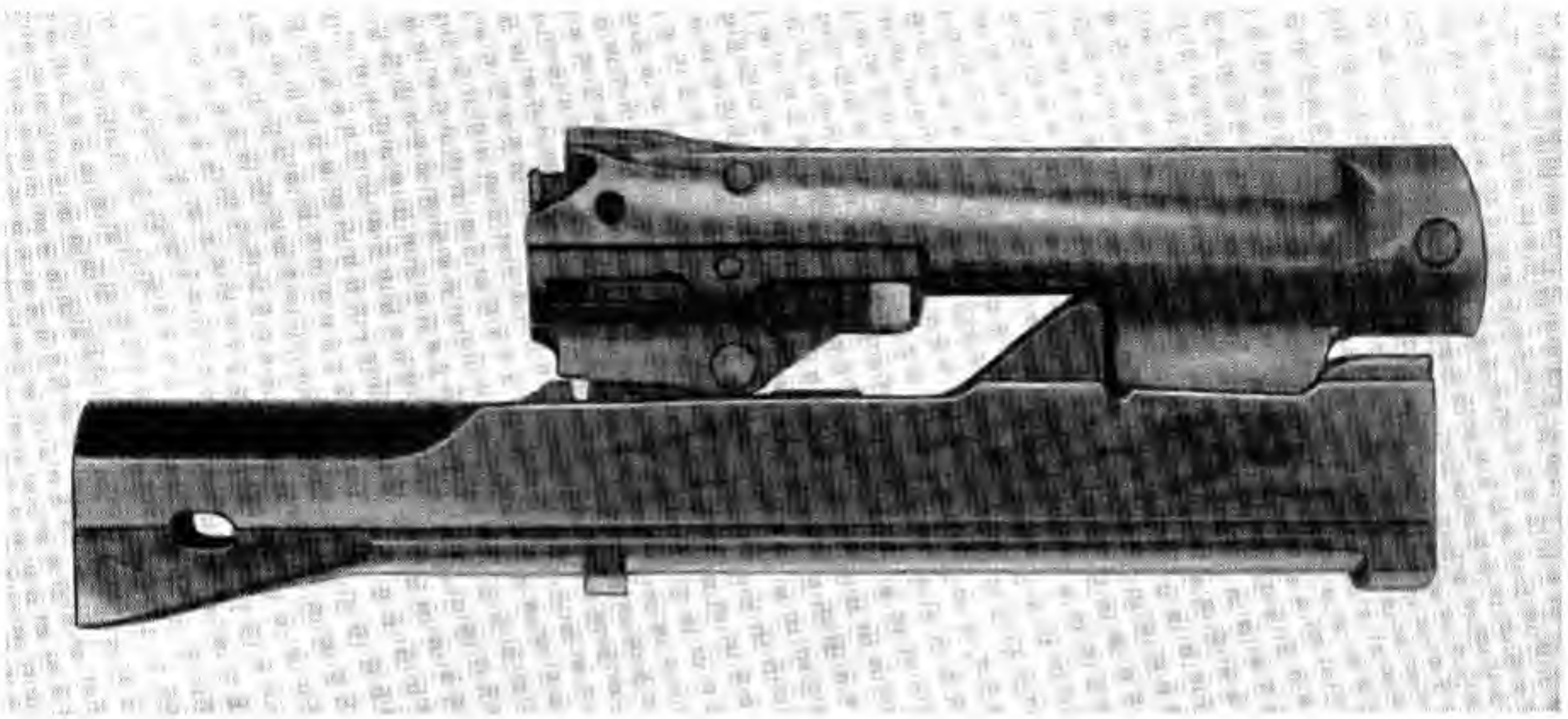


Figure 4 19. Bolt and actuating slide of the Shvak in the unlocked position.

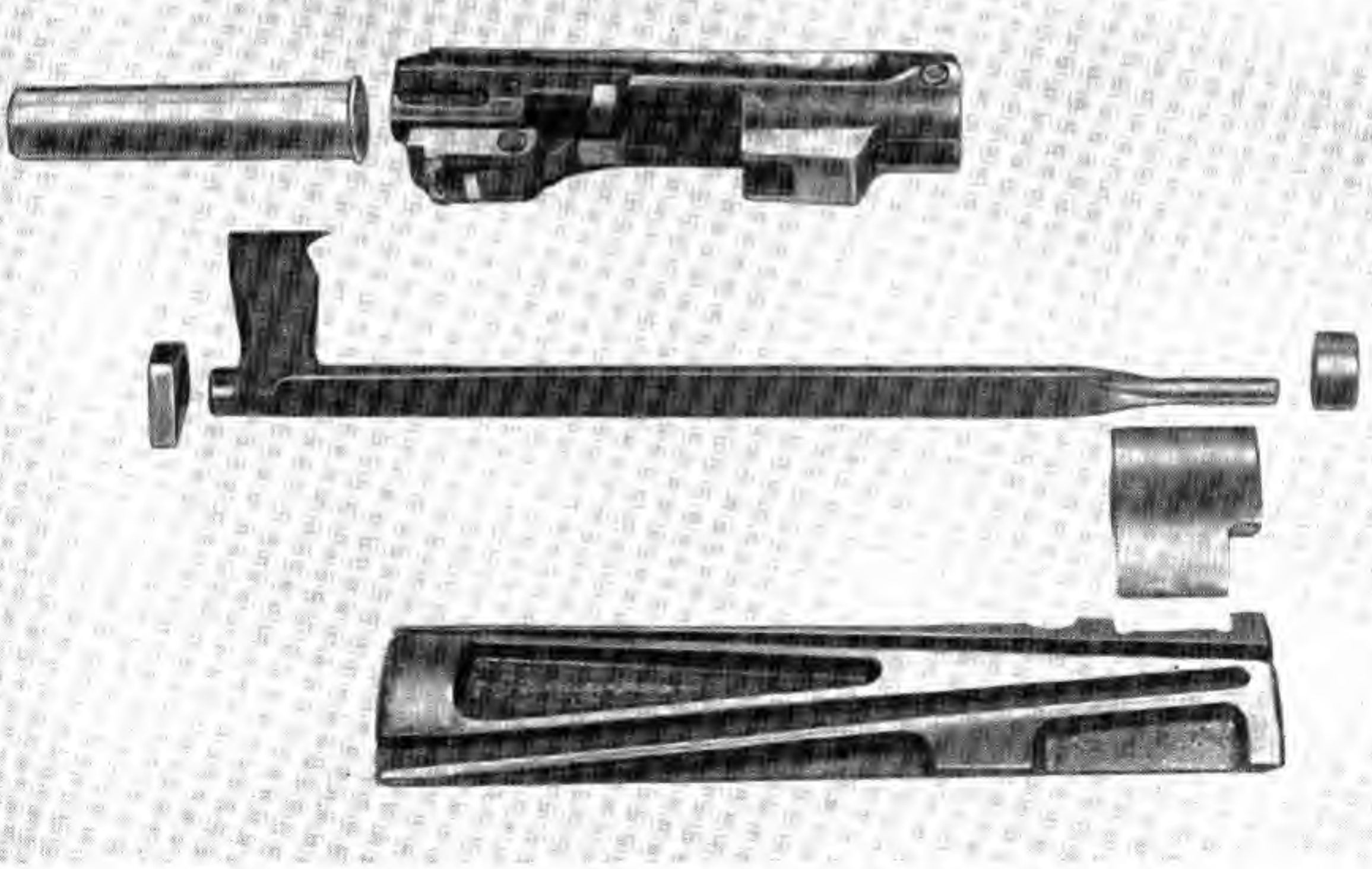


Figure 4–20. Shvak bolt and device which wipes empty cases from the face of the bolt.

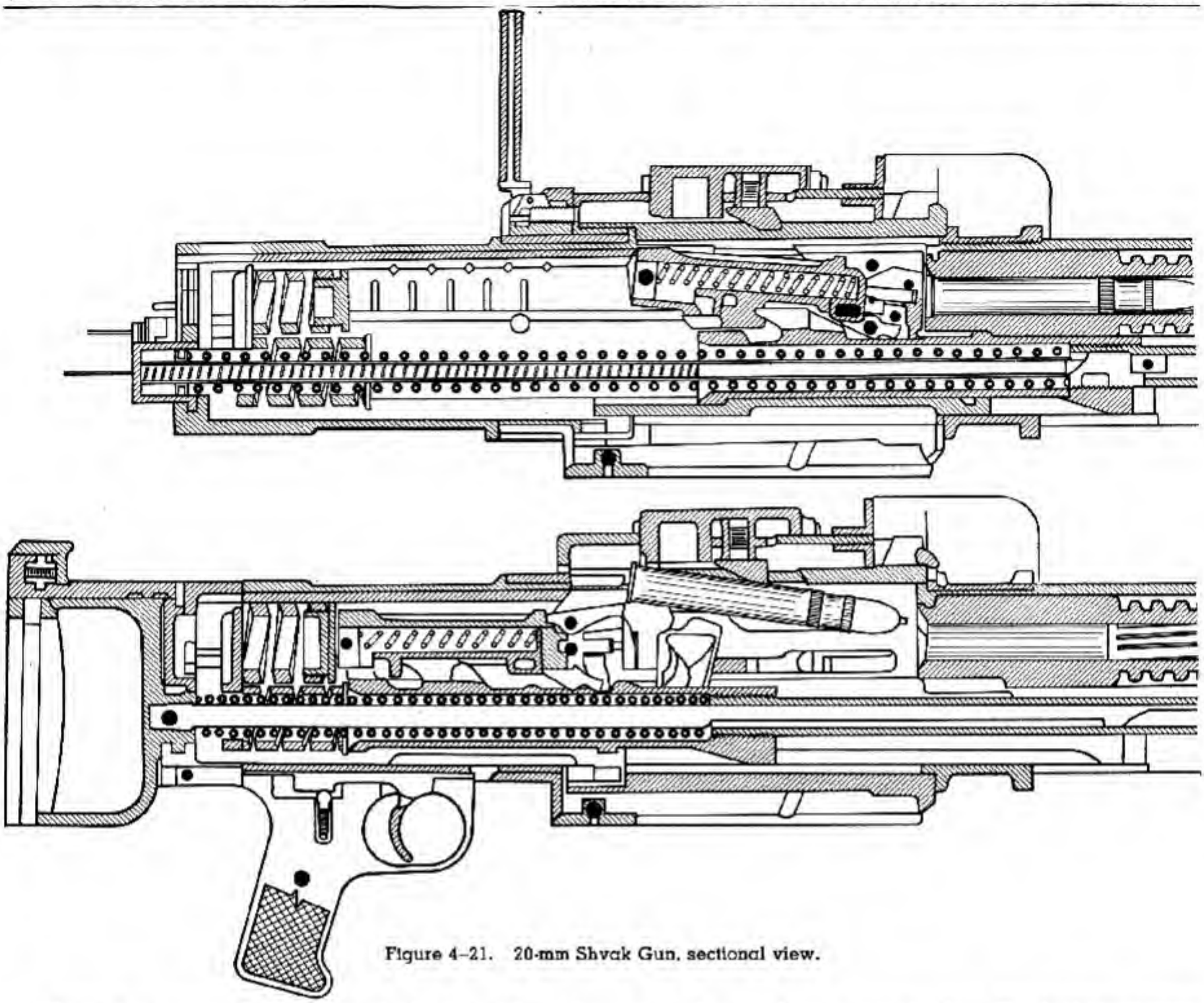
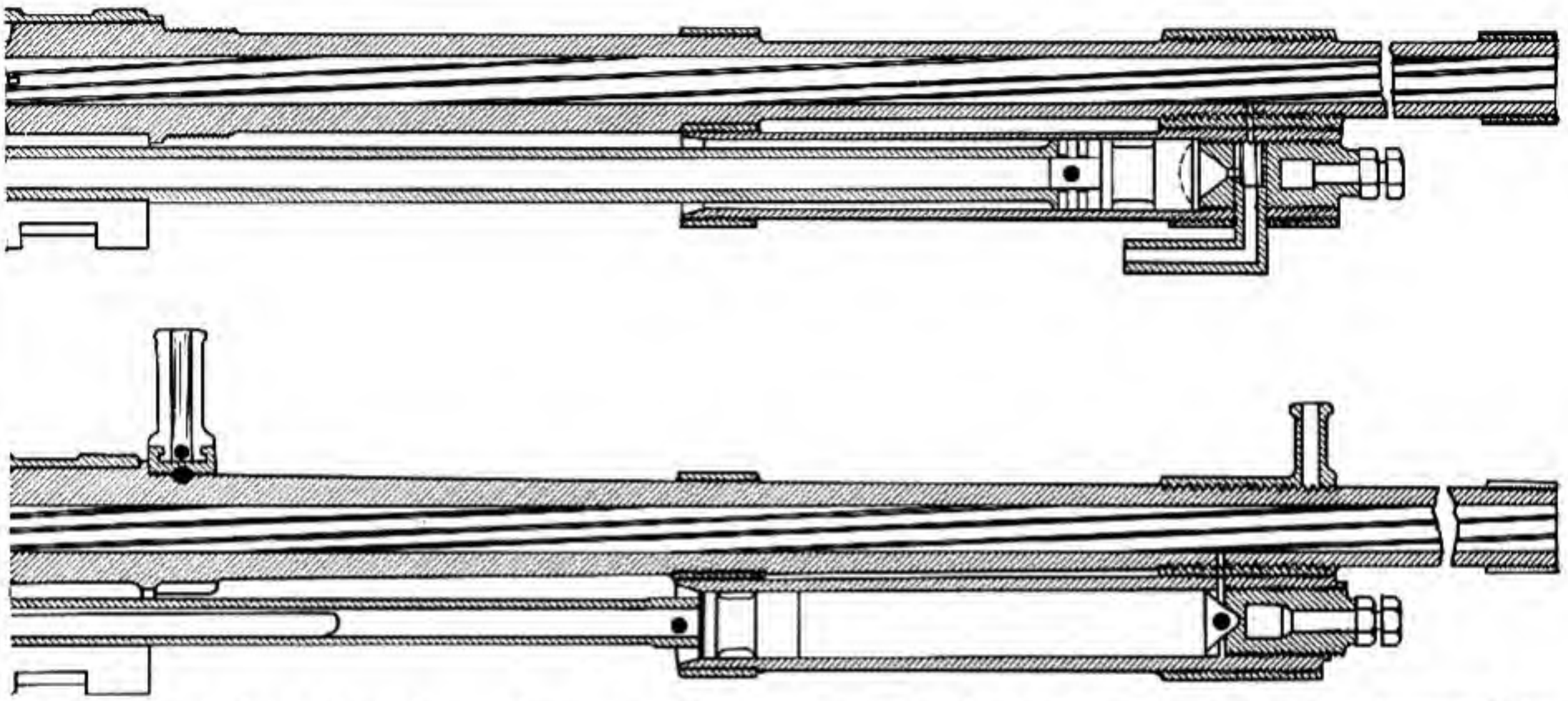


Figure 4–21. 20-mm Shvak Gun, sectional view.

There is a manual trigger and electric solenoid firing arrangement. The gun is fired by means of a cable when manual firing is desired. This cable protrudes through the rear buffer block. Attached to it is a catch or trigger which engages a hook on the end of a trigger bar; at the forward end of the bar is a trigger sear assembly fitted into the recess in the left-hand side of the gun. The trigger sear protrudes into the breechway and engages the hammer in the breechblock; when the cable is pulled, the bar is drawn to the rear and the sear is pulled inward to release the hammer. There is also an automatic searing device in the breechblock which engages the hammer when the hammer is forced back with the tongue of the piston post as the piston moves back to unlock the action. The automatic sear is released by a ramp at the rear of the recess in the piston extension making contact after the locking action has been affected by the piston still being in forward motion. The mainspring comprises four strands of $\frac{1}{16}$-inch diameter wire. The coil is $\frac{7}{8}$ inch in diameter and 37 $\frac{3}{4}$ inches long (free length). There are two heavy buffer springs, one for the breechblock and one for the piston extension. These assist in driving the recoiling portions forward on counter-recoil, as well as absorbing excess energy.

Cycle of Operation

The metallic link belt is pulled laterally into the feed by a cylindrical cage which rotates in a counterclockwise direction. During this rotation, the rounds are extracted from the belt by helical grooves in the drum, which exert a rearward camming action on the rim of the cartridge. When free of the



belt, the cartridge is forced into the center of the cage.

During the forward movement of the parts, the breechblock drives the cartridge into the chamber. The sloping projection at the rear end of the piston extension forces the rear of the breechblock upward into engagement with the locking shoulder in the body.

The piston continues to move forward, causing the sear to release the hammer, which flies forward and drives the point of the firing pin through the face of the bolt into the primer.

When the base of the bullet passes the gas port in the barrel, a portion of the gas is metered through the vent, and strikes the head of the piston; the piston extension then travels to the rear. When the piston has traveled approximately 0.4 inch to the rear, the striker post bears against the hammer forcing it to the rear. The inclined cam on the underside of the piston post forces the rear end of the breechblock downward from engagement with the locking shoulder in the body to unlock the breech. During this movement of the locking shoulder in the body, the raised portion on the sear has entered a recess in the piston extension, thus allowing it to engage the hammer.

Initial extraction occurs when the unlocking surfaces of the piston post engage the corresponding unlocking cams in the breechblock, causing the breechblock to drop and break contact with the locking shoulders in the body very slowly. Full extraction is now effected by the gas actuated parts being pushed to the rear. There are two recess shoulders on the face of the bolt into which the cartridge is positioned during the feeding cycle. These are in effect extractors; these claw-shaped spring-loaded pieces are situated in their side recesses.

A post serving as the ejector cam, which is connected to the feed slide, comes into contact almost at the extreme end of the rearward recoiling stroke. This action causes the ejector arm to sweep across the bolt face, engaging the cartridge case and forcing it into an ejection tube located in the right side of the body. At this point the guide ejection prong, situated on top of the ejection tube, guides and retains the cartridge case in the ejection tube.

Final ejection is completed during the forward movement, when the ejector arm moves upward out

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of the path of the breechblock, and a projection on the right side of the piston extension engages the base of the cartridge, driving it farther into the ejection chute.

A spring loaded stop is situated at the front of the ejection tube to prevent cartridges dropping back into the firing mechanism during firing at an elevated angle.

The piston extension strikes the buffer, rebounding into counter-recoil. On the way to battery, the face of the bolt picks up the positioned round in the bird cage feed, forcing it forward into the chamber. At this point, the breechblock arrives home, is tilted up, and locks into battery. The cycle of operation is repeated as long as the trigger is depressed.

Disassembly

The following procedure is adhered to.

Charge the gun by pulling aft on the cable coming through the larger boss in the rear, and release by pulling the other cable.

NOTE. Considerable tension is required to cock the gun.

Raise catch at rear of gun after securing the larger boss. Turn boss slightly to the right. Allow lugs to pass through clearances, then pull boss clear until rod and spring are protruding about 7 inches to rear of gun. Maintaining a firm grip on rod so as to counter tension on spring, pull cable back a few inches. Turn rod to the left to disengage front end from piston cotter key and ease off carefully rearward to remove rod and spring.

Make sure that recoiling parts are fully forward. Push in plunger in recess in right rear. Turn body and cap to the right until clear of separated flanges, then remove. Now remove roller on end of displacer rod.

Push up and remove buffer plate in rear of body. Take out piston and breechblock buffer springs. There is a protective covering over the springs.

Raise loading handle and rotate band as far as possible to the left. Unscrew and remove square-headed set screw. Return band to original position, pull back body casing until the rear end is just clear of the body.

Open cover in larger part of case. If feed cage has moved back with casing, push it forward so as to expose feed holes. Lift out front and rear end of pawls.

Open other cover in the casing which contains the cartridge positioning pawl. Then the body casing can be slid off the body rearward. Turn gun on right side and slide off rearward the feed cage, keeping left hand in position around body to prevent other components from falling out.

Lift out feed pawl operating slide from under side of piston; take ejection guide cam piece and spring from the recess in front side of body.

Force back the piston and remove displacing bar, pawl, and cam block. Remove also trigger bar with trigger sear block.

Remove spring clip retaining piston head by pushing out pin. Unscrew head and slide off clip.

Push piston to rear and remove bolt.

Press down on barrel locking piece screw, unscrew, and remove locking piece. Pull barrel forward and remove ejection chute.

NOTE. The recoiling portions should never be in battery when removing the body cap.

Assembly of Components

Assemble in the reverse order to disassembly, but note the following:

1. Piston carrier should be assembled with the flat uppermost. If this is not checked, the return spring, guide rod, and cocking piece with cable cannot be correctly assembled.

2. The hammer in the breechblock must be cocked to enable the breechblock to seat correctly on piston extension.

3. Make certain the displacer rod pawl and front end of rod are assembled correctly to conform with the contour of the body. Place the displacer cam block on the rear end of the rod so that its projection seats in the feed pawl slide before the piston and slide are pushed forward.

4. Keep the recoiling parts back halfway when replacing feed cage.

5. When replacing receiver, see that it is in correct alignment so that when pushed home, set screw holes are in correct alignment with recess in body.

6. It is more convenient to leave the ejection guide and spring out until ready to push casing forward. Then push home after assembling feed pawls.

7. When replacing end cap, be sure the friction cap is on the end of the displacer rod. Pull trigger cable out before rotating the cap to lock. Then

keep pushing the cable in as the cap is rotated to insure the engagement of the trigger catch with the hook of the trigger bar. Test when cap is fully assembled.

8. To replace return spring and guide rod, first push back the recoiling portions and then place a thin spanner wrench in the neck part of the piston head to prevent piston from going forward. With a small length of tubing which will fit over the bolt, engage the main stud on the boss with its catch. Push in guide rod and spring until rod is projecting only about $^{6}/_{32}$ inch. Then turn rod to the right; this is done by trial and error until the correct position is arrived at.

9. When the rod is free to turn, the cable will shoot forward denoting that the cocking piece on the end of the cable has passed the cotter. Turn the rod back slightly; the strain of compressing the spring is now taken by the cable end. Remove the spanner, push the rod home until lugs of boss enter recess in cap. Then turn to the left with the catch raised until the catch can engage in the recess in the side of the boss.

SECTION 3. SHVAK 12.7-MM MACHINE GUN (SHPITALNY-VLADIMIROV)

This gun was made at the same time as the Shvak 20-mm automatic gun and used the Degtyarev cartridge plus a rim. This is a rare gun; records show that the prototype was tested, but only a few guns were manufactured.

SECTION 4. SHVAK 37-MM AUTOMATIC GUN

Attempts were made to scale up the 20-mm to 37-mm size. It is assumed that this experiment did not meet with success, since no models have been found.

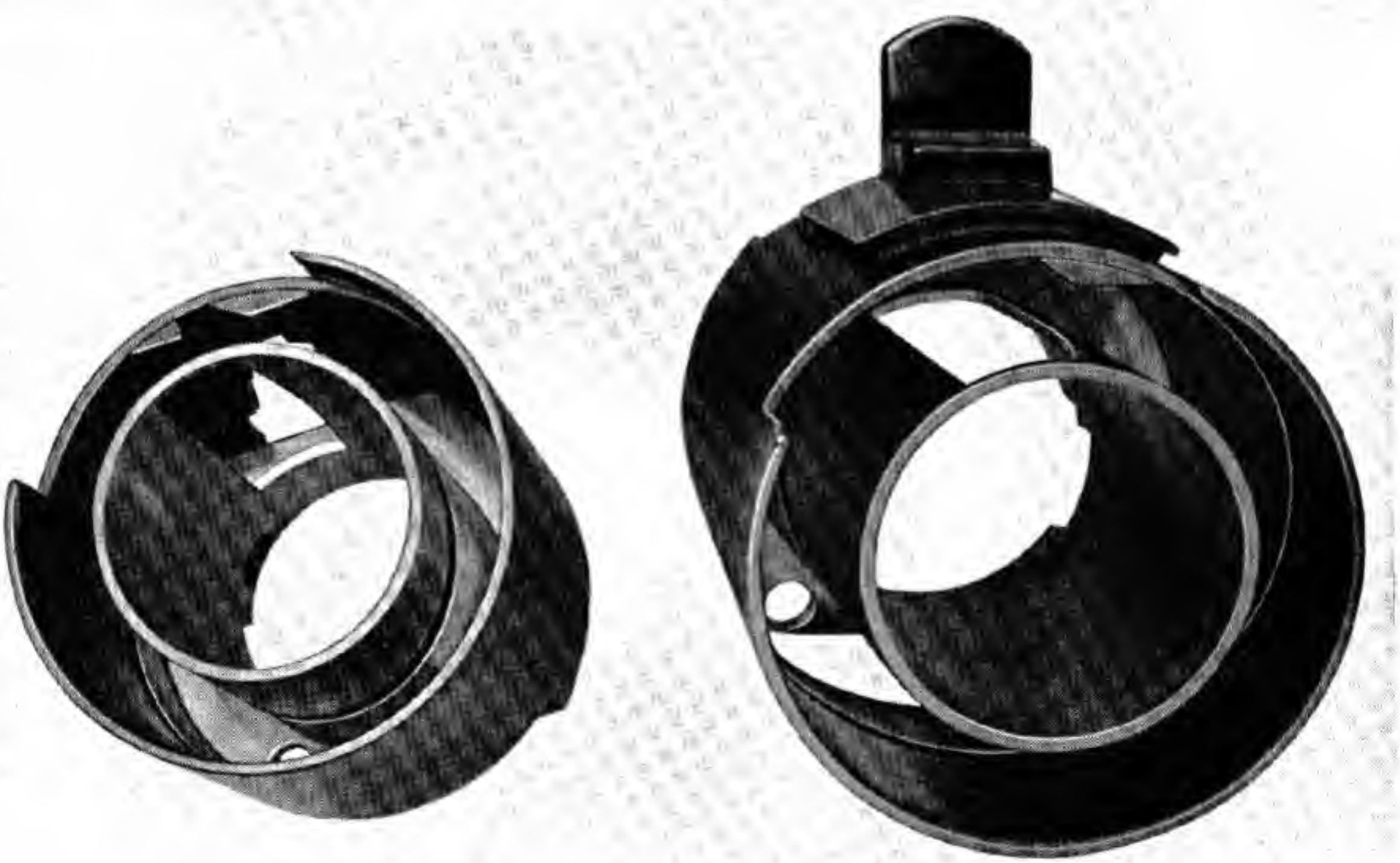

Figure 4-22. Part of the feed mechanism of the Shpitalny system. The cage rotates between the inner and outer cylinders with the rims of the cartridges sliding between the inner and outer helical grooves.

Chapter 5

BERESIN AIRCRAFT MACHINE GUN AND VYA AIRCRAFT CANNON

Weapons Included in This Chapter

Beresin Aircraft Machine Gun

Designation	Bore diameter	Use	Year of appearance
BS.....	12.7-mm	Fixed.....	1940
UBT....	12.7-mm	Flexible (turret).....	Early in World War II
UBK....	12.7-mm	Fixed installation in Wings.	
UBS.....	12.7-mm	Synchronized through propeller arc.	

VYa Aircraft Cannon

Designation	Bore diameter	Use	Year of appearance
VYa.....	23-mm	Fixed..	Early in World War II.

History and Background

Shortly after the invasion of Finland by the U. S. S. R., the Russian Air Force replaced the small-bore rifle caliber Shkas with the 12.7-mm Beresin Aircraft Machine Gun.

The Shkas was a comparatively intricate and well finished gun, the cost of which necessitated that it be kept in operating condition as long as possible by repair and replacement of parts. In contrast to the Shkas, the Beresin was deliberately expendable, that is, the Soviets' plan was to discard the entire gun after a short period of use during which one or another of the principal operating mechanisms became worn or broken.

The design of the Beresin machine gun was greatly influenced by a captured Lahti 20-mm machine cannon (see Volume 1, pages 596–597); many features of the Finnish gun appear in all models of the Beresin.

The earliest version was called the BS, which stands for Beresin Samolenti (Beresin Aircraft). Reports indicate that it was produced late in 1940.

Figure 5-1. The Finnish Lahti Machine Cannon, top view (above) and left side (below).

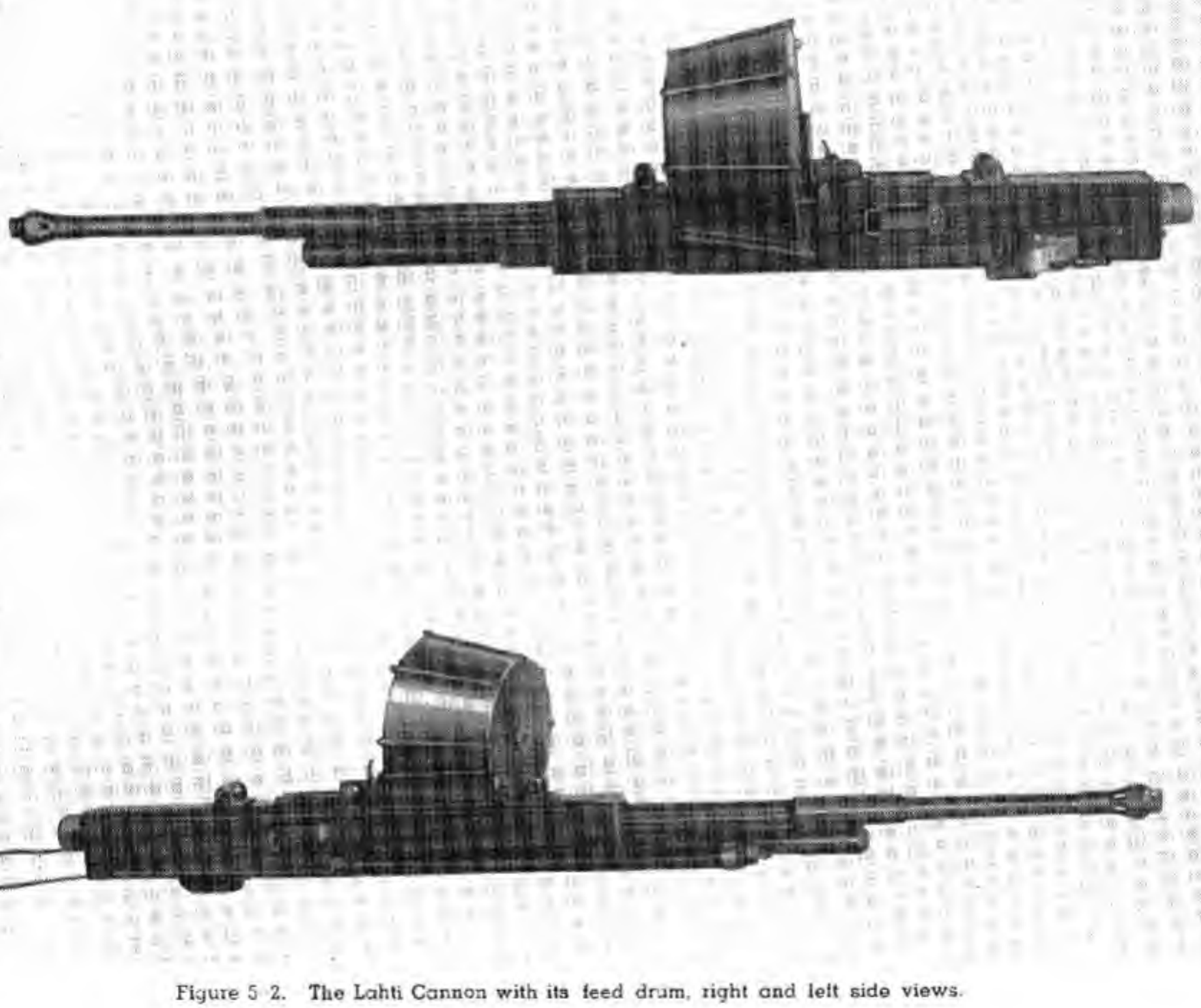

Figure 5-2. The Lahti Cannon with its feed drum, right and left side views.

The first instructors' manual put out for the field service was on what was known as the "Universal Gun" and appeared in 1941, a fact which seems to indicate that only a few of the BS type were made.

Later models were marked UBS, UBK, and UBT to show their intended method of mounting. The ones stamped UBT were for turret installations; the UBK guns were installed fixed in wings; while the synchronized weapons were given the designation UBS and fired through the propeller arc.

Since the larger caliber Beresin machine gun was designed to replace the rifle caliber Shkas in practically all aircraft, it was necessary to improvise a power system with an electrical servo unit to perform the lateral movement of the mid-upper turrets. Successful installation of two UBT 12.7-mm guns with ammunition boxes containing 500 rounds for each gun were made with this sort of arrangement.

This type of Russian offensive armament was not undertaken until well along in World War II. The Russian General Staff held that the low mental level of the masses would necessitate training that would be too expensive in both time and money to warrant construction of many such complicated devices.

VYa Aircraft Cannon. When it became apparent that rifle caliber machine guns were not adequate for the arming of aircraft, the Russian High Command, still following their fixed policy of using only proved and reliable weapons, ordered the engineering design team of Volkov and Yartsev to take the battle-tested Beresin automatic firing mechanism that was then being made in 12.7-mm only and scale it up to use a high velocity 23-mm cartridge.

Figure 5-3. F. N. Volkov, one of the two engineers whose initials appear on the 23-mm VYa Gun.

The Soviets' choice of engineers for this all-important job proved sound, for in a short time there appeared an automatic aircraft cannon that is identical basically with the well known Beresin. This weapon was the first-line aircraft cannon throughout World War II and was used extensively in close air support.

The identification VYa is derived from letters in the names of the designers.

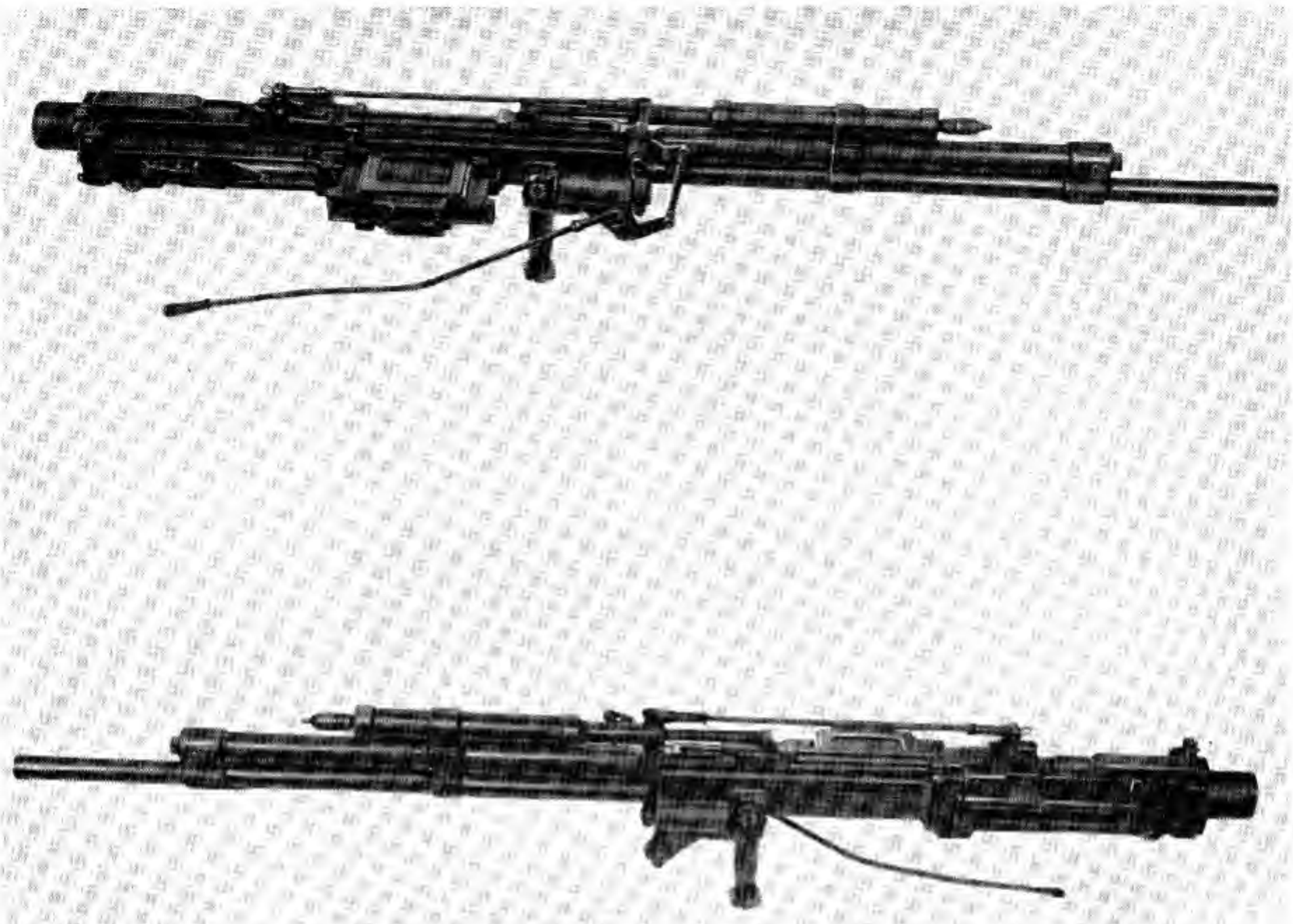

Figure 5 4. The 12.7-mm Beresin Aircraft Machine Gun.

SECTION 1. BERESIN AIRCRAFT MACHINE GUN

General Data

Caliber: 12.7-mm.
Rate of fire: 700–1,000 rounds/minute.
Muzzle velocity: 2,800 feet/second.
Gun length:
UBS and UBK: 53 inches.
Gun height: 6.3 inches.
UBT: 55 inches.
BS: Not standardized.
Gun weight: 47 pounds–56 pounds.
Gun width: 5.9 inches.
System of operation: Gas.
System of locking: Lateral stirrup-shaped piece moves across into recess in receiver.
System of feeding: Disintegrating belt.
Method of cooling: Air.
Method of charging: Pneumatic (manual on free gun).
Barrel weight: 13.5 pounds.
Barrel length: Rifled part, 35 inches.
Barrel removal: Not quick change.
Chamber pressure: 44,000 psi.
Bore:
Number of grooves: 8.
Groove depth: 0.0066 inch.
Groove width: 0.11 inch.
Pitch: 6°02′27″.
Direction of twist: Right hand.
Form of twist: Constant.
Method of headspace: Barrel wedge.
Location of feed opening: Right side.
Location of ejection opening: Left side.

Description of the Weapon

The Beresin was designed primarily for aircraft use; however, the earliest model, the BS, was readily adaptable to antiaircraft use and was applied to a variety of ground armament, especially on armored vehicles.

The weapon is gas operated. The firing pin is not spring loaded. It protrudes beyond the bolt face just far enough to detonate the primer when it is driven by a pivoting piece striking the receiver. Removal of the empty cartridge case from the face of the bolt is accomplished by a rib running through the bolt body, camming the empty case clear of the receiving walls.

The guns designated UBS and UBK are charged pneumatically, while the UBT is loaded by a hand lever and has a much heavier and longer barrel than the other two guns.

The weapon is rear seared and there is no provision for single shots, firing being full automatic only. As an auxiliary safety device, if needed, the gunner can hold the bolt by the pneumatic or manual charger to the rear.

Feeding is always done by a metal, pull-out type link belt. The bolt always remains in a cocked position at the end of each burst to exclude the possibility of accidentally firing the cartridge due to a "cook off" in an overheated barrel or chamber. The Russians also went so far as to have a special alloy for their bullets, which they claim gives prolonged life to the barrel.

Feeding is performed from the right side only and is not interchangeable. A modern metal disintegrating link belt is used. The links fall from the right side of the receiver after the withdrawal of the cartridge, which is a very unusual feature. Ejection of the empty cartridges is done through a slot in the left side of the receiver, on the opposite side from which the gun is fed.

These peculiar characteristics no doubt were purposely incorporated in this weapon to give a cleaner installation, in harmony with the Russian practice of mounting aircraft guns beneath the engine cowling. In fixed installations, a heavy spring-loaded arrangement is invariably found, in which the forward part of the gun is supported flexibly by two

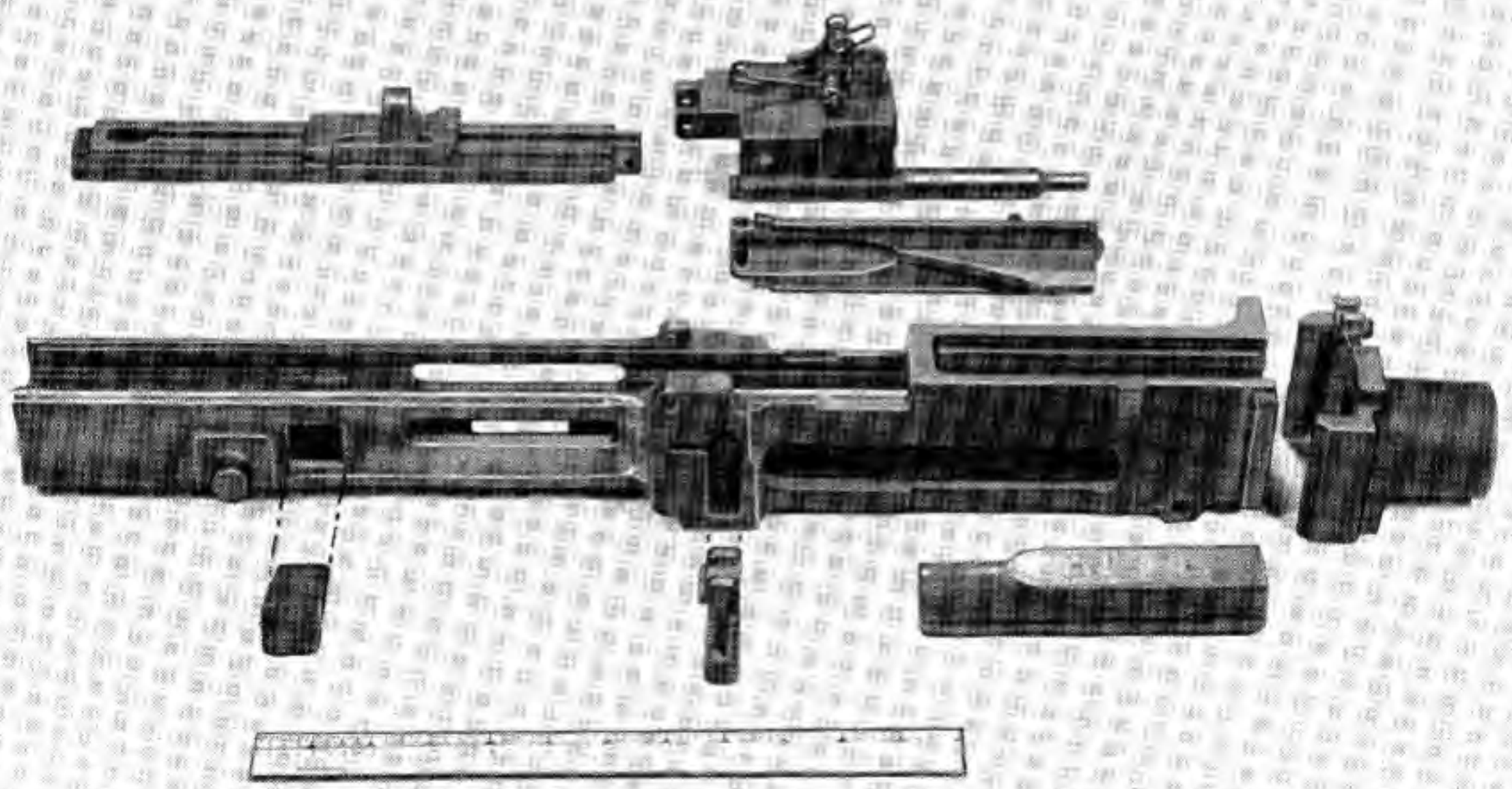

Figure 5–5. Receiver group of the Beresin, disassembled. In the foreground are the barrel retaining wedge (left) and the bolt lock (center), with dotted lines indicating their recesses in the gun body.

trunnions on the body casing, while the rear is fastened in a sliding plate that can move back and forth in a rigid yoke.

Locking of the Beresin is accomplished by forcing the U-shaped breech lock into its locking recess by advancing a sliding bar or bolt extension.

This weapon is sturdy in construction and follows the Soviet procedure of wasting as little effort as possible on the exterior appearance.

As with other Soviet mass-produced weapons, semi-skilled labor is used to the utmost on parts that do not have to be made with finesse or precision, whereas the operating components receive separate manufacture and intricate milling by qualified workmen. The whole weapon is assembled at a plant devoted solely to such activities. Where filing is required for fitting, no attempt is made to remove the marks, and no finish is employed solely to better the outward appearance of the gun.

At first, omission of hardening caused the weapon to have a quick drop in rates of fire after the soft metals began to burr and deteriorate from use. Correction of this flaw soon followed, but only the parts that were offending the most were hardened. However, the weapon, like so many of the earlier guns, was reliable regardless of its crude workmanship.

For aviation use, the Beresin uses both general and special types of ammunition such as tracer bullets, armor-piercing incendiaries, and explosive bullets which have sensitive and immediately reacting fuzes. The Beresin series uses one type of cartridge which is used in the DShK Degtyarev-Shpagin Heavy), but it will not employ the same type of ammunition belt.

The defensive armament of the first Russian aircraft equipped with this gun was very primitive. Gun positions and turrets were generally hand operated; this imposed heavy physical demands on the air gunners. The chance of scoring hits under these conditions was correspondingly impaired.

The UBT, UBK, and UBS include the following modifications of the original BS. Other changes were of a minor nature.

a. The weight was increased by 2 pounds.
b. Components could not be interchanged.
c. Improved belt feed mechanism.
d. Improved connection of the slide and piston.
e. Changes in the groove in the slides.

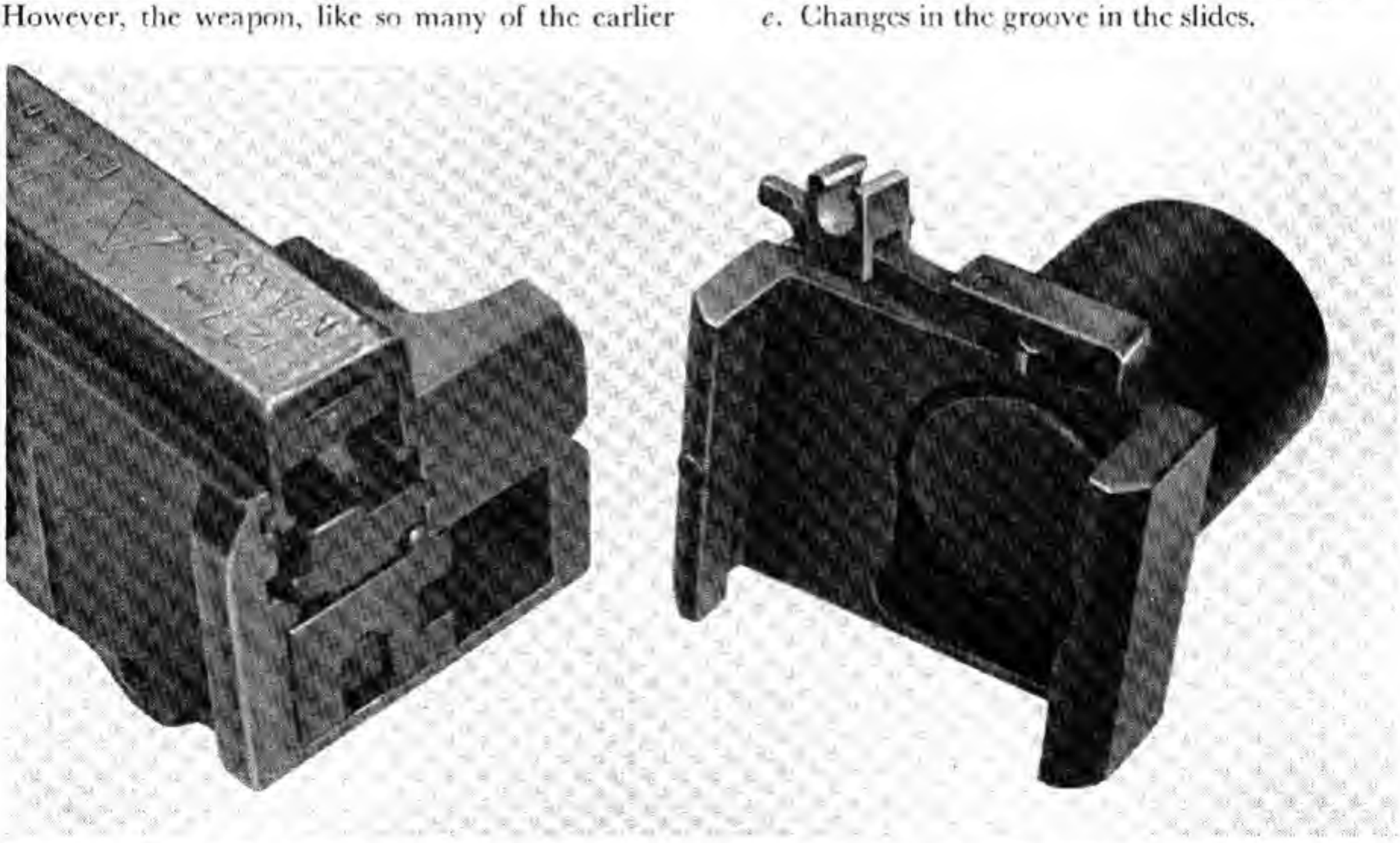

Figure 5–6. Rear of the receiver of the Beresin Machine Gun, showing backplate with buffer removed. This method of gun construction uses the backplate to prevent spreading tendencies of the sideplates.

f. Improved method of securing the firing mechanism to the receiver.

g. Change in the provision for fastening the buffer to the gun.

Cycle of Operation

To fire the Beresin, the operator pulls the first cartridge from a feed box on the right side of the receiver, and pushes the cartridge and its link under the belt-holding pawl. The bolt must be fully forward.

The charging handle is pulled all the way to the rear, and a T-slot on the bolt face, which is connected to the gas actuating piston, withdraws the cartridge from the belt and positions it farther down in the T-slot. The disintegrating link drops out of the right side of the receiver. The rear sear holds the operating mechanism back in the cocked position with the cartridge against the bolt face.

When the trigger mechanism is actuated, the bolt and gas piston are driven forward by the compressed driving spring. The bolt arrives in battery first and is now behind the chambered round with the locking piece directly over the cuts in the breech lock plate in the receiver. The gas piston is held to the rear by the lug engaging a small swinging portion resting in its recess in the bolt.

The gas piston now cams the U-shaped lock in the receiver and the lock then takes it place in the breech lock plate. At the same time, the pivoting member swings outward, permitting the gas piston to travel onward. As the face of the semicircular firing pin is freed by the raising of the U-shaped lock, the firing pin strikes the end of the receiver and pivots, thus driving the pin into the primer which in turn fires the cartridge.

The stirrup, or U-shaped locking piece, holds the bolt face securely behind the base of the cartridge in the chamber until the bullet passes the barrel's gas port. A certain amount of gas is then bled into a cylinder located on the barrel, and it starts the piston to the rear by the time the bullet has cleared the

Figure 5–7. A Beresin Machine Gun used for antiaircraft defense by Soviet ground troops in World War II. The light-weight barrel does not permit long bursts of sustained fire in such an installation.

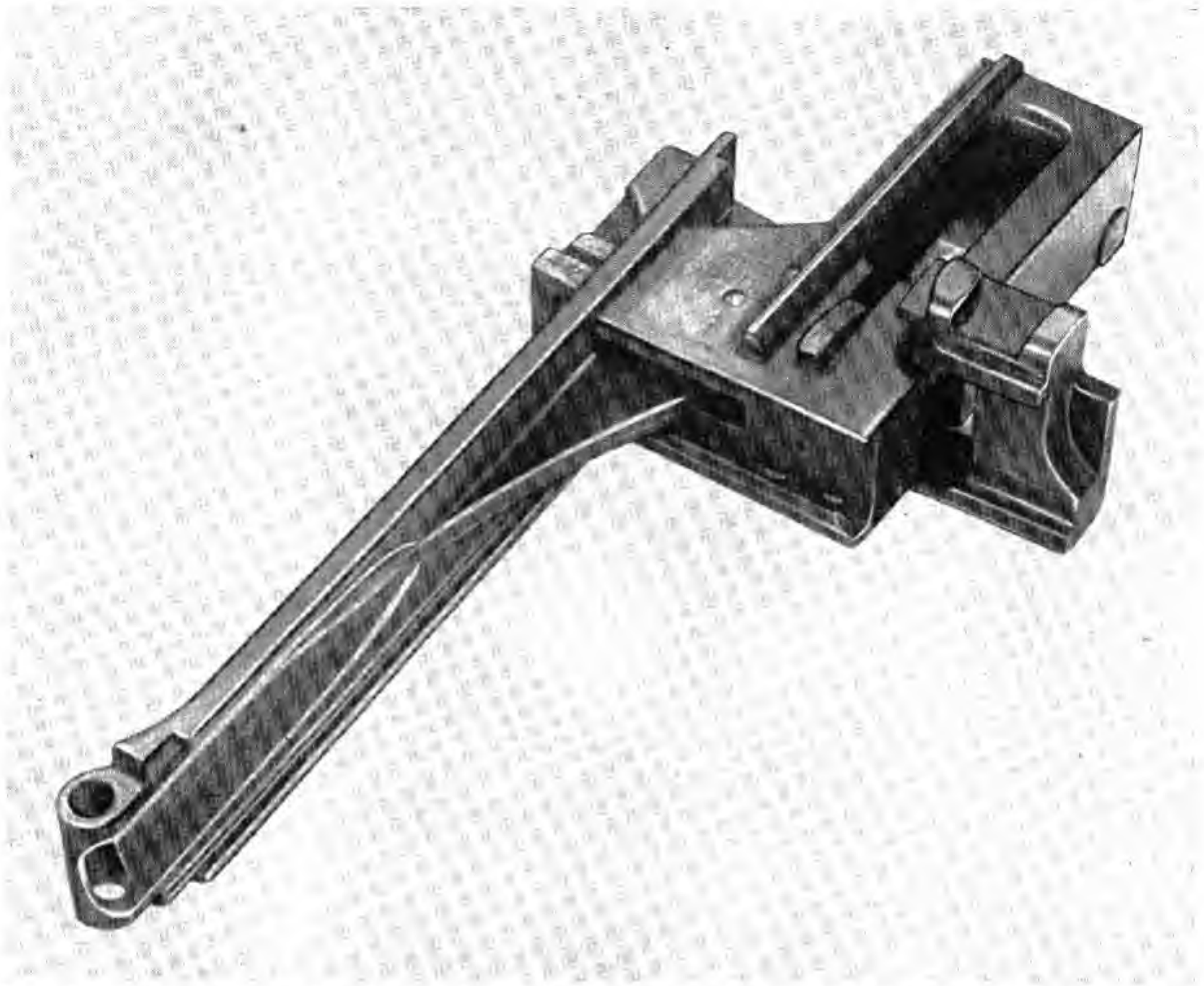

Figure 5-8. Important elements of the Beresin action. The bolt (center) slides between the fixed feed cam (left) and the bolt lock (right). The lock has only lateral motion in relationship to the receiver.

bore. In the first fractional part of its movement, the piston partially retracts the positioned cartridge in the feedway and places it into the T-slot, where complete recoil of the bolt assembly withdraws the round fully from the link and a ribbed arrangement cams it into the T-slot. In the first half inch of recoil, the lug of the gas piston releases the breech lock, which moves gradually to the left before totally unlocking.

This system of two-stage unlocking permits a gradual creeping of the bolt rearward to loosen the round, thereby performing a function known as initial extraction. By the time final unlocking of the bolt is acomplished, the cartridge has been fully loosened and the T-slot extractor needs only to hold the empty case in position for ejection. This takes place at a distance from the breech end of the barrel, which is greater than the over-all length of the loaded cartridge.

A rib enters its slot in the bolt body, causing the loaded cartridge to force the incoming round to the left and to drive the spent case through an ejection slot in the left and aft side of the receiver. This last act places the incoming cartridge in the T-slot, in position for chambering.

The base of the loaded cartridge cams back the free-floating firing pin. The rib causing this action is of very unusual shape, being uniform in width and

increasing in height at an accelerated rate. The gas piston and bolt asembly continue to recoil until it strikes an unusually heavy spring buffer deflecting it into counter-recoil. If the trigger is held down, the cycle of operation is repeated.

The cyclic rate of fire can be adjusted for use in a synchronized installation by means of four gas orifices marked 3.2 mm., 3.0 mm., 2.8 mm., and 2.6 mm.

Disassembly of the BS by Groups

1. Release the sear lever, unscrew the rotatable part 1¼ inches to 1½ inches to the rear of the rearmament cable. Release the cable and the movable parts, seeing to it that the spring does not fly up.

2. Drive out the bolt and pin that hold the pivot in the bottom of the synchro-mechanism box. This act disengages the components from the breech.

3. Prepare the barrel for changing by removing the pin with pliers and the bolt with a wrench or similar tool.

4. Separate the barrel from the breech by unscrewing and removing.

5. Separate the piston rod, the piston, and the recuperator spring from the slide. Remove the outer tube of the piston rod (by turning ¾ to ⅞ of an inch to the left).

6. To remove the rear plate, pull to the back the bolt which is holding the back plate. Remove the cotter pin, thus releasing the bolt. The back plate and the spring in the back plate must be removed carefully so that the spring will not fly up.

7. Release the trigger pull mechanism from the back along with the guide for the breech housing.

8. Remove the cover from the feed belt.

9. Remove the breech guide and the pins by using pliers.

10. Pull the breech bolt and its slide to the rear and separate one from the other.

11. Remove the breech and the breech bolt.

12. Remove the feed lever, and separate the plunger from the feed lever.

13. Disengage the cartridge belt.

Assembly of the BS by Groups

1. Replace the cartridge belt holding pawls.

2. Replace the breech bolt in the breech.

3. Start the removable slide breech into the breech block as follows: Place the movable breech in the guideways of the receiver. Completely couple the breech with the slide, then fit the guide into the breech.

4. During assembly, the breech spring is replaced in the slide.

5. Place the feed lever in the feeder collar, and check contact with the conduit breaker before the sear is placed in the breech.

6. Put the feed table in place.

7. Place the feed belt cover in the slide.

8. Assemble the piston rod with the slide. To raise the breech, adjust the spring by turning the lug of the rod to an angle of 30° or 40°. Connect the slot in the slide with the lug of the rod. The plunger bracket is placed to hold the cover securely. Turn the socket of the piston rod until it engages the receiver.

9. Assemble the barrel with the receiver. To operate properly, the barrel must be held securely. Care must be exercised to make sure that the barrel enters the enclosure of the receiver.

10. Place the locking device of the barrel into the receiver; position the barrel-holding wedge by pressing firmly toward the right until it fastens securely.

11. Place the trigger mechanism in the receiver by pressing it all the way into its groove guides.

12. In placing on the back plate, put the front wings of the buffer into the receiver in such a manner that the face of the disk is even with the front of the back plate.

13. Mount the synchronizer mechanism in the receiver. Place the half circular disk in position and press it into its housing, put the bolt toward the rear to serve as pivot point in the box. Release the bolt during the mounting. Be sure that the lever is engaged with the sear.

Other Procedures

Manuals issued by the Russian Army concerning the maintenance and operation of the Beresin machine gun indicate that hammering and filing of the parts is considered necessary for the fitting of components in the field.

The following quotation is taken from a Russian manual. "In inspecting the barrel, be perfectly sure there are no swelling or splits; if there are, the barrel must be replaced. The end of the barrel entering and locking in the breech must be cleaned with emery and a file. The brazes and scratches of

the rifled part of the barrel are removed with a very light emery. Clean with patches of cotton cloth on a ram rod, then with oil, passing the cotton patches through until they come out clean. Inspect the chamber for longitudinal small scratches. The transversal scours and scratches must be removed, as they cause jamming of the barrel; therefore, it is of the utmost importance to clean the bore well at all times. During the inspection of the chamber of the gun, make certain that there are no cracks or splits or swellings in this portion or any places where the movable parts would contact during firing. Be certain to use emery and polish the chamber and the parts inside. The bracket is released and cleaned separately."

This manual includes a check-out list for ordnancemen to use before a plane takes to the air. It is given here:

"Before combat flight, the machine gun must be lubricated and checked. Note that the barrel and breech bolt are correctly assembled. Note that the cartridge belt is started correctly, the pawl is in operating condition and the belt moves freely, and that there are no malformed cartridges in the belt. After the mounting of the machine gun in the airplane, it is necessary before feeding to verify the functioning as follows: by the aid of the pneumatic system of the re-arming lever, arm the machine gun. This type of machine gun cannot feed while the bolt is in battery. To feed, place the movable parts in a forward position engaging the first round in the belt. This positions the center pawl one space forward. Be sure that the feed pawls are operating correctly. Check the springs and their action. Check the sear and the actions of the scar. To arm the machine gun completely, it is necessary to retract the recoiling parts to the extreme rear. These parts are now against the sear, and the cartridge in the T-slot ready for chambering. The machine gun is ready to fire."

This manual also includes a table of malfunctions that were the most prevalent with this gun; the first one listed is the faint strike, or non-firing primer. The causes of this are listed as:

a. Bad quality of cartridge.
b. The spring too weak.
c. The percussion spring broken.
d. The firing pin badly worn or broken.
e. The breech lever worn out.
f. The sear release lever not in the receiver.
g. Disassemble and clean the removable breech.

The remedy given for each of these situations is as follows:

a. Reload the magazine and continue to fire.
b. Replace the percussion driving spring, afterwards making certain the cause of malfunction was a result of a bad spring.
c. Change the firing pin pivot pin.
d. Change the firing pin.
e. File the guides of the receiver.
f. File the breechblock so that the part enters its groove. The clearance should be as much as 0.005 inch. The plunger of the firing pin can now enter freely.
g. Disassemble and clean the removable breech.

The second most prevalent malfunction listed is "the cartridge stuck in the chamber." As in the No. 1 malfunction, the cartridge was named as the first cause. These statements suggest that there was considerable trouble with defective cartridges.

The causes of case seizure in the chamber are listed as:

a. Bad quality of cartridge.
b. Not adequately lubricating the weapon and its ammunition.
c. Friction of the belt in the feed guide.
d. Recuperative spring too weak.
e. Recoil incomplete.
f. Trigger badly worn.
g. Coupling worn out.
h. Cartridge extractor worn.

To remedy this fault, the following remedies are listed:

a. Reload the machine gun and continue to fire.
b. Disassemble and clean, and inspect all operating parts at regular intervals.
c. Inspect the belt, feed guide, and support.
d. Replace the recuperative spring.
e. Examine all movable parts.
f. Replace the lever of the automatic trigger.
g. Replace the coupler.
h. Replace the cartridge pawl.

This manual states that of the ten most common malfunctions encountered in the field, 85 percent were traced to bad cartridges; and, further, that when all the cartridges are fired and the last one is

not ejected, if the bolt is not caught on the sear it returns to battery forcing the empty cartridge case back into the chamber, which by now is overheated. The usual result is the cartridge stuck in the chamber, making it necessary to cool the gun for removal of the empty case.

SECTION 2. VYα

General Data

Caliber: 23-mm.
Rate of fire: 650–750 rounds/minute.
Muzzle velocity: 2975 feet/second.
Gun length: 84.53 inches maximum.
Gun width: 6.18 inches.
Gun height: 7.6 inches.
Gun weight: 145.2 pounds.
System of operation: Gas, piston operated.
System of locking: Lateral stirrup-shaped piece moves across receiver into locking recess.
System of feeding: Disintegrating belt.
Method of charging: Pneumatic (manual on free gun).
Method of cooling: Air.
Barrel length: 64.96 inches.
Barrel removal: Not quick change.
Chamber pressure: 47,200 psi.
Bore:
Number of grooves: 10.
Groove depth: 0.0138 inch.
Groove width: 0.205 inch.
Pitch: 5° 34′ 27″.
Direction of twist: Right hand.
Form of twist: Concentric (postwar models have progressive rifling 40/28 calibers).
Method of headspace: Barrel locking wedge.
Location of feed opening: Right side.
Location of ejection opening: Bottom.

Description of the Weapon

The Russian automatic aircraft cannon known as the VYa 23 mm is a scaled-up version of the 12.7 mm Beresin and, like the Beresin, is gas operated and depends on little or no blow-back force to assist in the cycle of operation. The weapon was designed primarily for aviation use. It employs a pneumatic charging system to retract the bolt assembly and index the first round. The design permits the cooling of the barrel only by air.

Feeding is accomplished by the use of metal disintegrating links that come apart when the loaded round is pulled toward the rear. The empty link is then guided through the remainder of the feed system and drops out of the left side of the receiver. There is no provision to reverse the feeding, it being from right to left only. The empty cartridge cases are cammed out through an opening in the bottom

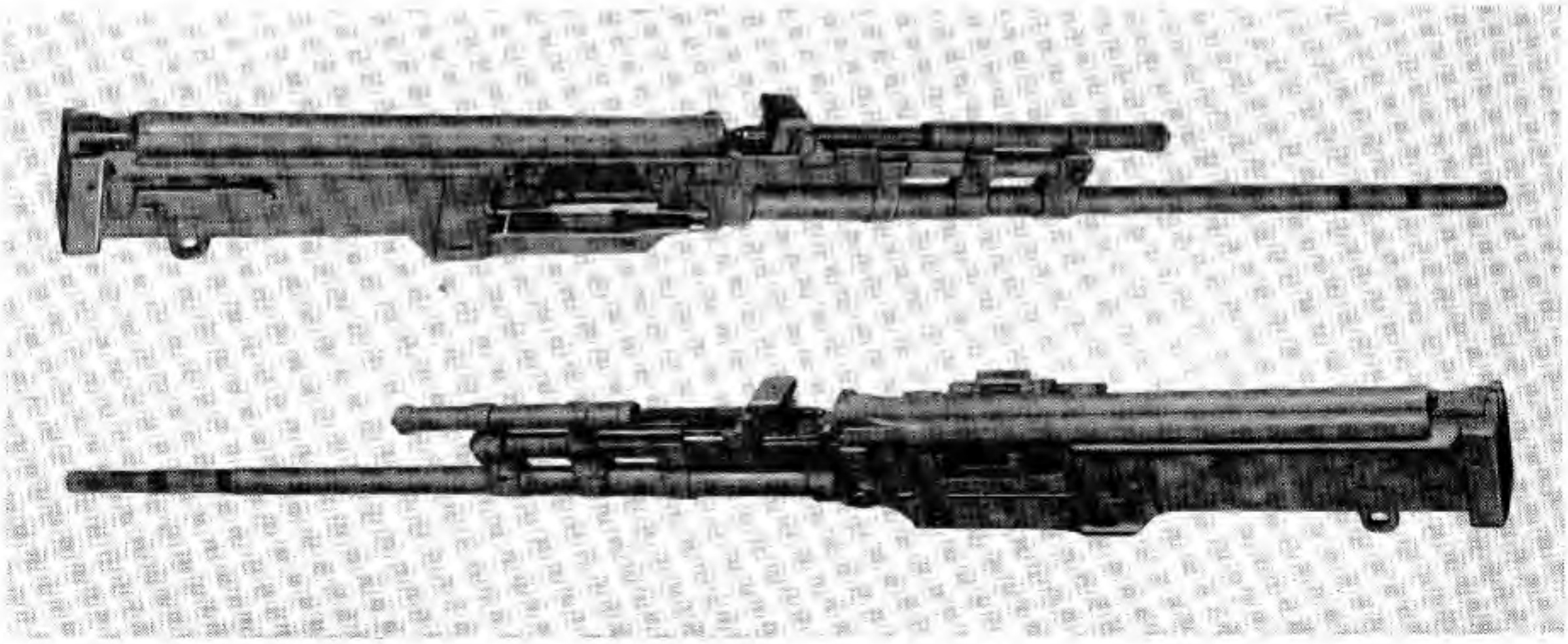

Figure 5–9. The 23-mm VYα Automatic Cannon.

Figure 5 10. VYa Cannon undergoing firing tests at Aberdeen Proving Ground, Md.

of the receiver that is slightly rearward of the feed way.

The weapon operates from gas impact on the piston and has four different sized orifices to regulate the amount of gas required for different rates of fire. The dimensions are 3-mm, 3.5-mm, 4-mm, and 4.5-mm. The first or normal, setting is 3.5 and is reported to give a cyclic rate of 700 to 750 rounds per minute.

All loading and charging for the initial shot is done by the pneumatic system. This action is identical with the Beresin. One distinct difference between these two guns is that the VYa cannot be synchronized.

The components of this gun are not interchangeable, alterations to insure a workable fit usually being done in the field and accomplished by the simple method of filing or honing until the desired clearance is obtained. Like all its predecessors, its construction is rough and even the inside has a minimum of machining cuts.

Regardless of its external appearance, the VYa is a rugged, compact, hard-hitting gun. It was used successfully by the Soviet Air Force during most of World War II, principally for ground support. Its large-diameter high-explosive projectile has an unusually high velocity. This feature made the gun excellent in low-flying attack on light tanks and armored vehicles.

The gun consists of the following main groups, listed by the Russians as follows: barrel with gas cylinder and pneumatic cocking mechanism; breech with breech rail; receiver with buffer assembly; cover; feed system; trigger assembly.

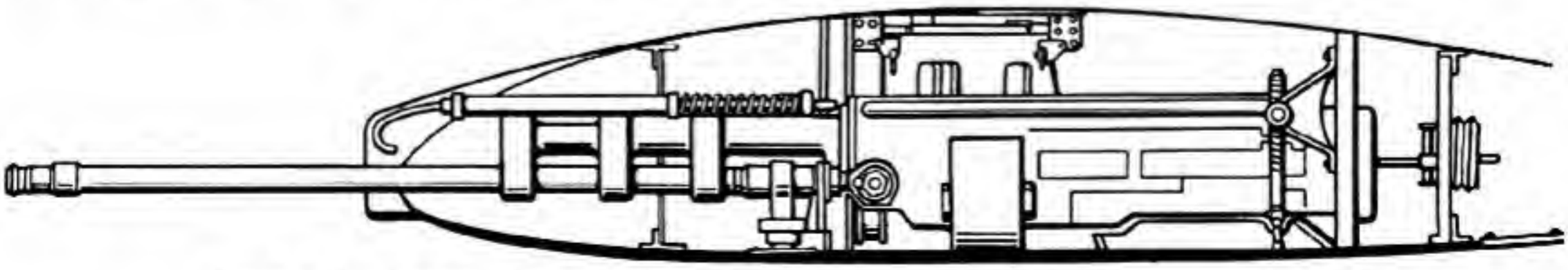

Figure 5 11. Method of mounting the VYα Gun in the wing of the Soviet IL-2 Airplane.

Figure 5-12. Armorers installing a VYa Cannon in a Soviet plane.

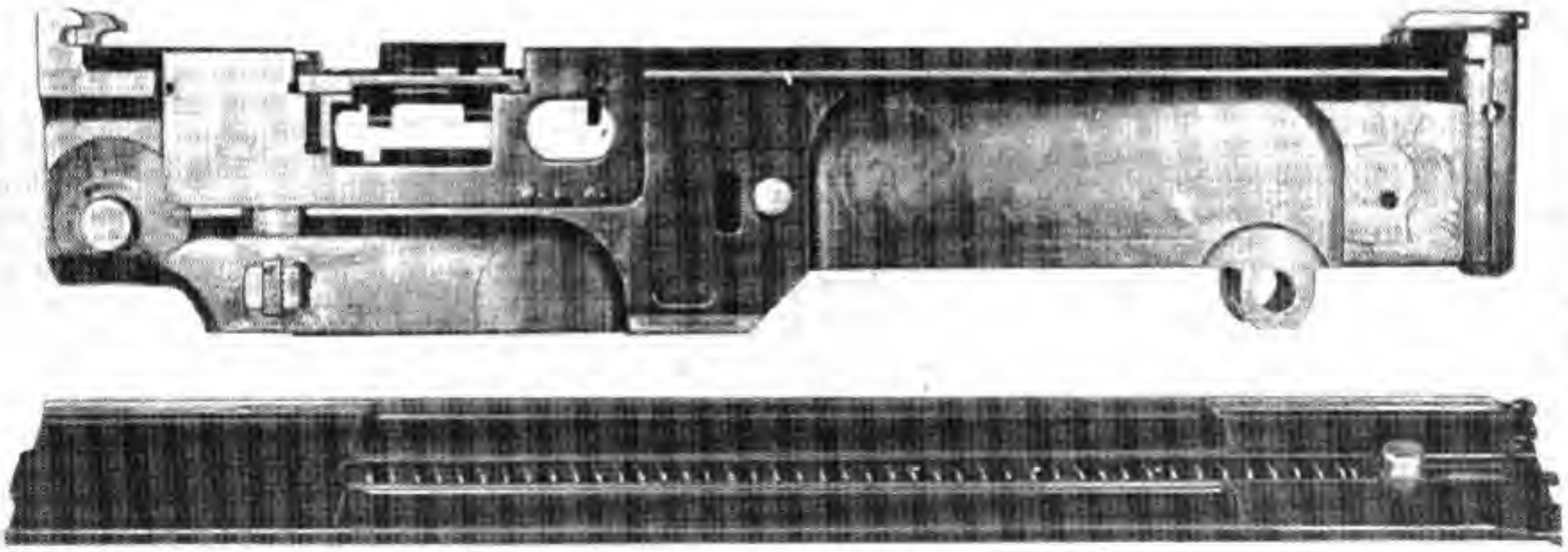

Figure 5-13. Receiver of 23-mm VYa Cannon. For similarities to the Beresin, see also figure 5-5.

Figure 5-14. Operating slide and piston of VYa Cannon.

The barrel is 64.9 inches in length and is held rigidly to the receiver by the insertion and driving fast of a wedge-shaped piece that also serves the purpose of maintaining the headspace incorporated during manufacture.

The breechblock is attached to the breech rail. These parts move together as a single unit. The gas cylinder is attached to the barrel, together with the gas piston and the gas piston block. While the charging system is located above the gas piston assembly, one structural group is formed by the joining together of these parts.

Before the cartridge belt can be inserted, the gun must be cocked. As the jaws of the T-slot interfere with the passage of the cartridge, the feed slide is guided by a cam in such a manner as to index the incoming round in position to be picked up and started in the T-slot in the face of the bolt. The part known as the breech rail is guided in the receiver by its slots, and its front end is struck by the gas actuated piston. This force drives the rail to the rear, unlocking the breechblock. The gas piston itself is separate from the rail and serves only to give energy to the latter part.

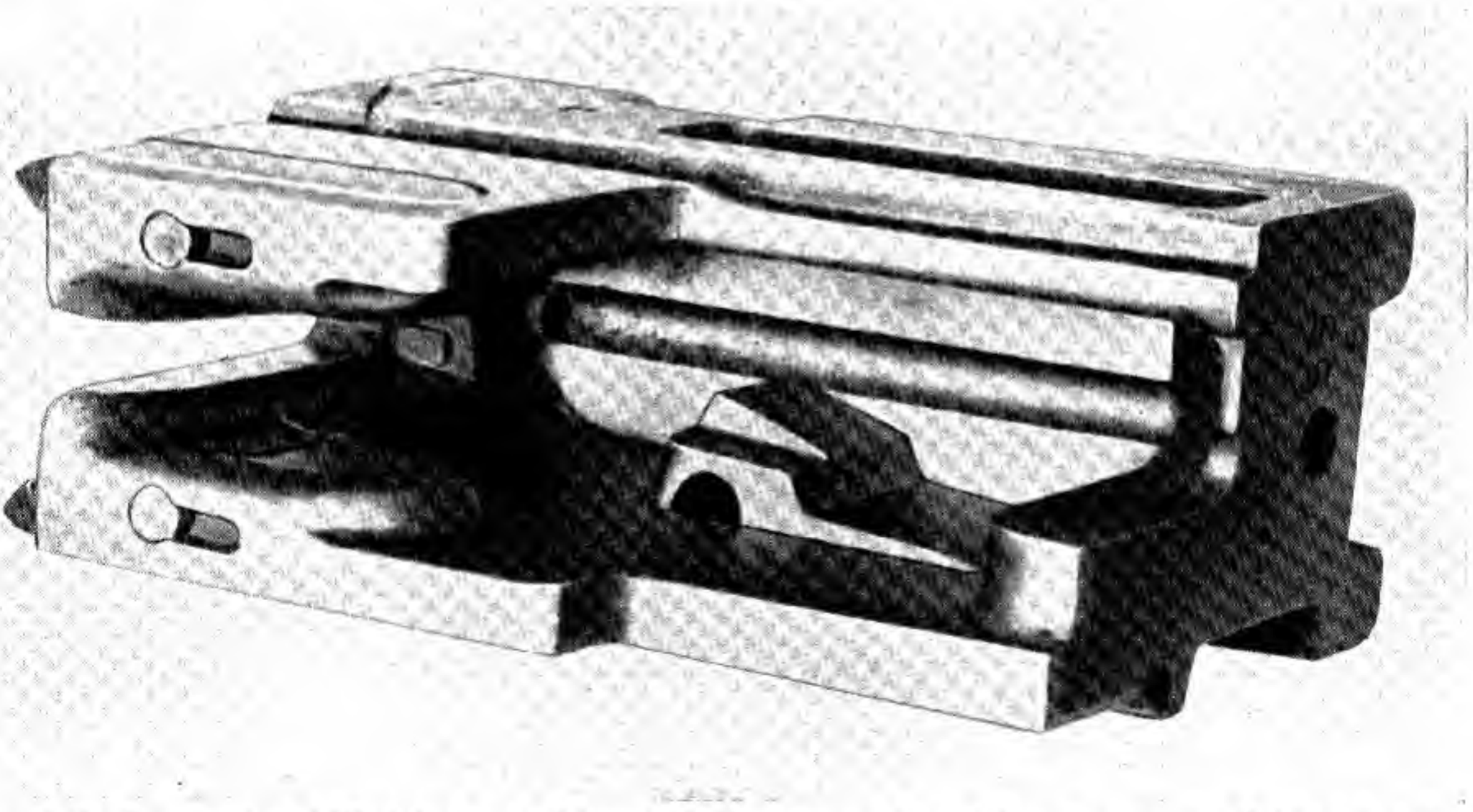

Figure 5-15. Top rear view of VYa bolt, showing "pincers" which extract round from belt and position it in T-slot for feed cam.

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Figure 5-16. Operating slide of VYa Gun, showing groove for stud of belt feed. Large lug at left fits in hollow portion of bolt.

The breechblock is locked by a U-shaped wedge which moves in the casing vertically to the axis of the bore, the locking wedge being controlled by the fore-and-aft movement of the breech rail. The cam of the feed slide runs along a groove machined in the rail. An additional cut-out at the front end of the breech rail engages a piece that functions as an anti-bounce device.

Attached to and housed in the breechblock is the firing pin, which floats free until the receiver and breechblock are securely held together. At this time the breech rail has reached the end of its forward travel, and a lug on the rail strikes the firing pin. At the top of the breechblock, two spring-loaded jaws draw the incoming round from the belt.

Attached to the left-hand side of the bolt and housed in a recess is a small pivoting member. This piece holds the breechblock and breech rail together during recoil. The receiver is box-shaped in appearance and is equipped with longitudinal grooves for guiding the breech rail and breechblock. The front end of the receiver has a bore just large enough in diameter to admit the barrel. At the rear, sturdy ribs hold the bolt assembly securely. This portion is used as an abutment for the buffer assembly with the buffer plate and for the cartridge guide cam that has to be pushed into the rear end of the receiver when the parts are assembled.

The cover group is used for closing the receiver to keep out foreign matter and provide a ready opening for visual check and maintenance of parts. The feed mechanism is inserted from the top into its grooves and is secured in place by the cover that, in turn, is secured to the receiver by four screws. The feed slide and the feed catch fit into the upper part of the feed housing. The slide is controlled by a rib riding in a curved slot that is machined into the breech rail. The cartridge holding pawls are located in front and behind the feed slide. These pawls engage the cartridge from the top and hold

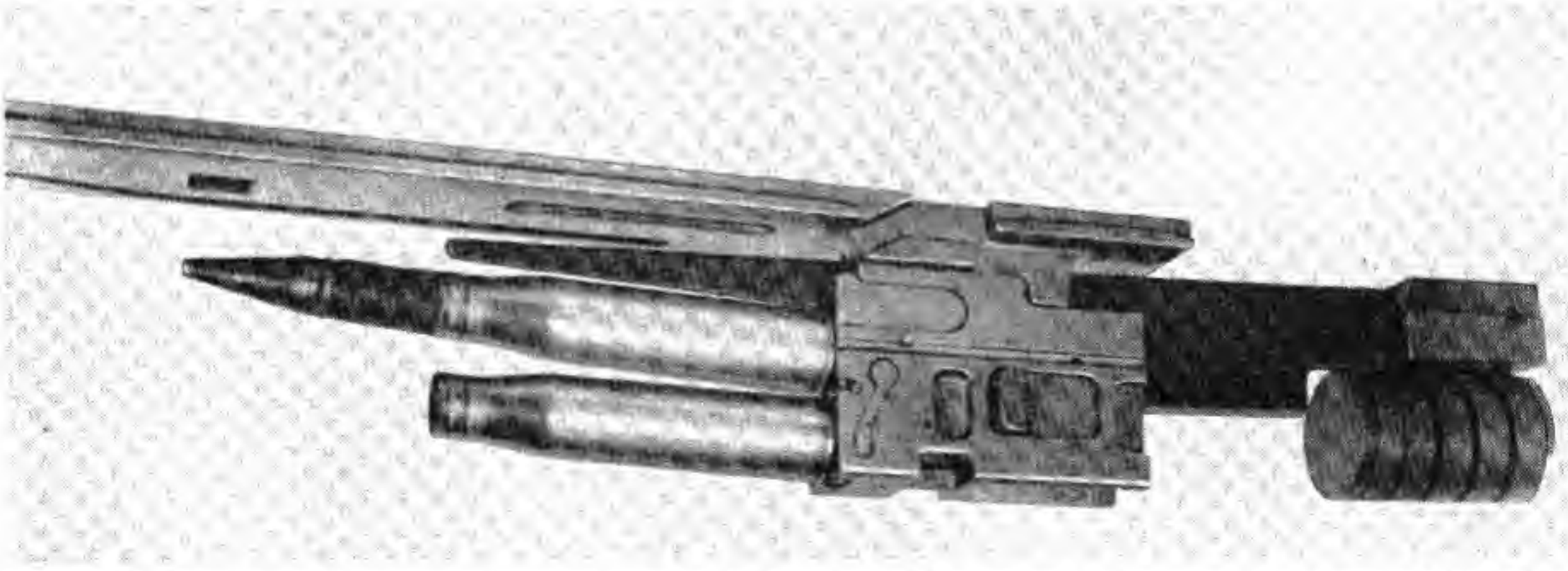


Figure 5-17. First phase of positioning incoming cartridge in T-slot of the VYa cannon. A live round, which was withdrawn from the belt by "pincers" at the top of the bolt, is being cammed downward in the T-slot and the empty case is being pushed out.

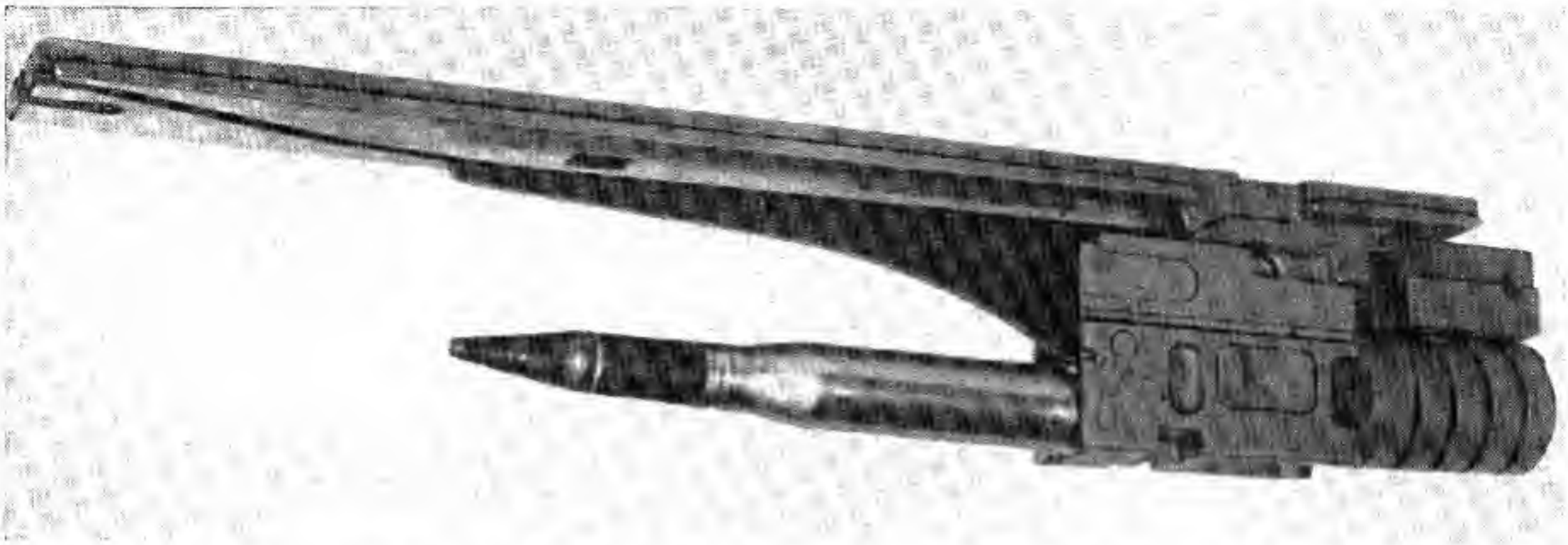


Figure 5–18. Final positioning of cartridge for chambering in the VYα cannon. The bolt has reached its buffer and the incoming round has been forced down to the centerline of the chamber.

it in position for being picked up and placed in the T-slot.

Cycle of Operation

To fire the VYa, the gunner first actuates the pneumatic charger, pulling the breechblock and breech rail to the rear until the sear is engaged. The cartridge belt is then inserted from the right side until the first round is behind the belt holding pawls and positioned so as to enter the spring-loaded jaws. The trigger is pulled, allowing the breechblock to fly forward and seize the rim of the first round.

The weapon is again cocked. This act withdraws the round from its link, the link falling from the left side of the feedway as the round is cammed down into the T-slot until it is in position for chambering. The weapon is now cocked and ready for firing.

Upon actuating the trigger, the breechblock starts forward, driven by the energy of its driving spring, the cartridge is chambered by the continued movement of the breechblock. At the farthermost travel forward, the U-shaped breechblock locking wedge rises vertically, cammed into its locking recess in the receiver by the last fraction of an inch of forward movement the breech rail can make after the breechblock is all the way home. This final travel brings the lug on the breech slide in contact with the firing pin driving it into the primer of the cartridge.

The barrel, breechblock, and breechblock lock remain securely fastened together until the projectile has cleared the bore. However, when the port in the barrel is passed by the projectile, a portion of the gas is metered onto the head of the piston, striking it a smart blow which in turn drives the breech slide rearward. The first movement of recoil allows the stirrup-shaped lock to disengage slowly at first before being totally unlocked.

This gradual withdrawal, with the T-slot holding fast to the cannelure of the fired round, causes the empty case to be jacked slowly rearward freeing it from the chamber walls. The lock has raised and the empty cartridge is free to ride back, held to the bolt face by the T-slot. A rib rides through a slot in the body and upper forward portion of the breechblock and cams down into the T-slot the incoming round, that has been picked up by the spring-loaded jaws and is now withdrawn from the link.

As the loaded round is forced into alignment with the chamber, the empty cartridge case is pushed out of the T-slot and through an opening in the bottom of the receiver. As the breechblock continues rearward it strikes the heavy spring buffer, compressing this piece and sending the firing mechanism back into counter-recoil. The recoil catch prevents further recoil of the breech rail. During backward travel of the breech rail, the bevel attached to the front end of this rail forces the recoil catch upwards. This catch then locks into the front cut-out under pressure of its heavy spring.

If the trigger remains depressed the firing cycle is repeated.

Disassembly by Groups

Remove the cover toward the top by depressing the locking bolt and pushing the cover latch backward. At the same time, the buffer assembly can be pulled downward. The cartridge cam and the breech buffer spring with the buffer plate can then be extracted toward the rear.

When the pneumatic cocking mandrel is pushed backward, the recoil catch is lifted and frees the breech rail together with the breechlock. After the trigger is pulled, both parts can be removed from the rear and the U-shaped wedge toward the top. After the trigger is pushed to the stop, the entire trigger assembly can be removed from the side. After the four screws are loosened, the entire feed mechanism can be taken from its guide grooves by lifting.

The barrel, that has fastened to it the carrier for the gas cylinder and for the pneumatic cocking device, is pulled toward the front after loosening the wedge. This frees the gas piston with the gas-piston block, which then can be disassembled toward the rear. After the threaded cap is unscrewed, the pneumatic cocking mandrel together with the piston and the spring can be extracted toward the front.

Disassembly of the gun into these parts is sufficient for cleaning. No special tools are required.

To Remove Barrel and Assembly:

1. From the left side of the receiver withdraw the receiver barrel lock retaining slide upward out of its recess, and push the receiver barrel lock to the right and out of the receiver.

2. Rotate the barrel and assembly to disengage the barrel lock from its recess in the receiver, and pull the barrel and its assembly out of the receiver.

Assembly by Groups

1. Replace the breech lock assembly by inserting it into its recess in the fore part of the receiver.

2. Place the belt holding pawl into the guideway of the feed assembly, and slide to the right.

3. Insert the device for camming down the cartridge into its guideway from the rear of the receiver.

4. Replace belt feed slide plate into the guideway in the top and rear of the receiver.

5. Before sliding the breechblock completely forward engage it on the under side of the breechblock feed slide plate.

6. Replace the breechlock receiver by pushing in on the lock projecting on the left side of the bolt.

7. Push the entire assembly forward until the sear within the right side of the receiver stops the bolt.

8. Pull back on the sear arm outside the receiver. This action withdraws the sear, allowing the bolt and belt feed slide plate to go forward.

9. The camming projection on top of the belt holding pawl must be in alignment with the guideway on the under side of the belt feed slide plate.

10. Replace the cover.

To Replace Barrel and Assembly. Reverse the procedure for removing barrel and assembly.

Chapter 6

NS AND N SERIES OF AUTOMATIC AIRCRAFT CANNON

Models Included in This Chapter

Designation	Bore diameter	Use	Year of appearance
NS 37	37-mm	Fixed	1943.
NS 23	23-mm	Fixed	1947.
N 37	37-mm	Fixed	Since 1947.

History and Background

In July 1943, the Russian Air Force introduced into service their first deviation from gas operation in automatic aircraft weapons, the NS. The gun proper was designed by Alexander Emmanuelovich Nudelman, one of Russia's top ordnance engineers. The pneumatic feed system was originated by A. Suranov, another armament specialist who was highly respected by the authorities of the U. S. S. R. The weapon is sometimes called the NS in honor of Nudelman and Suranov.

In World War II, the Russians stressed tactical support of ground action by their aviation. In operations against ground targets, it was well known that the 20-mm and 23-mm class of cannon were relatively ineffective. It was for this reason that the Nudelman-Suranov 37-mm gun appeared. It has been used successfully against armored vehicles and fortifications as well as more vulnerable targets, such as railroad trains and ordinary buildings.

The NS 37 is a 37-mm short recoil operated aircraft cannon with a rather slow rate of fire. The use of the short recoil principle in this weapon is a revolutionary step in aircraft armament development. Heretofore, the Soviet automatic weapon program, from light infantry machine guns to large caliber aircraft cannon, was designed to utilize the forces of gas for operation.

The NS and N guns use the same locking principle as the well-known German MG–151/20 aircraft cannon; namely, a two-piece bolt with a rotating bolt head. This part is so designed that the rear portion of the bolt is accelerated to the rear at the instant of total unlocking and timed so that the aft end is cammed rearward with great force, making contact at the instant of unlocking. This action speeds the recoiling movement of the whole unit and makes possible a high cyclic rate with a minimum of working parts.

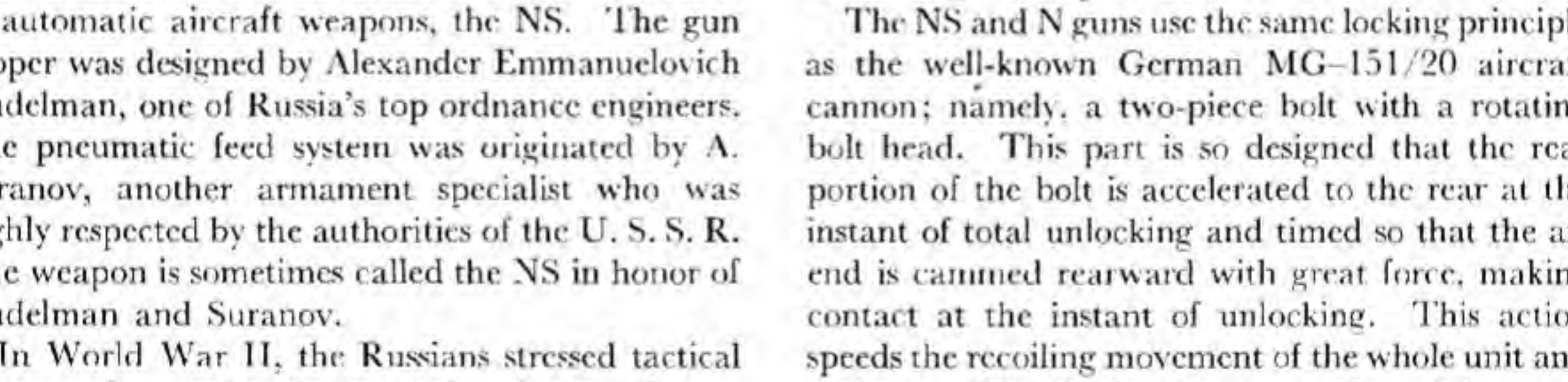


Figure 6-1. Left view of a 37-mm NS Cannon from underneath, showing the lines to the air flask and firing controls.

Figure 6-2. Soviet armament engineers who worked on the NS Series. Left to right: Gribkov, Bundin, Lebedev, Nudelman, Richter, Suranov.

In the late eighteen nineties, Ferdinand Mannlicher originated the rotating bolt head that unlocked the action of the weapon. He used it successfully in a military rifle that was named for him; however, it was the Mauser plant located at Oberndorf, Germany, that revived this system of locking just prior to World War II and applied it so well to automatic weapon design, both ground guns of rifle caliber (MG-81 and MG-34) and aircraft cannon (MG-151/20).

Since that revival, the system has been imitated in automatic weapon construction by practically

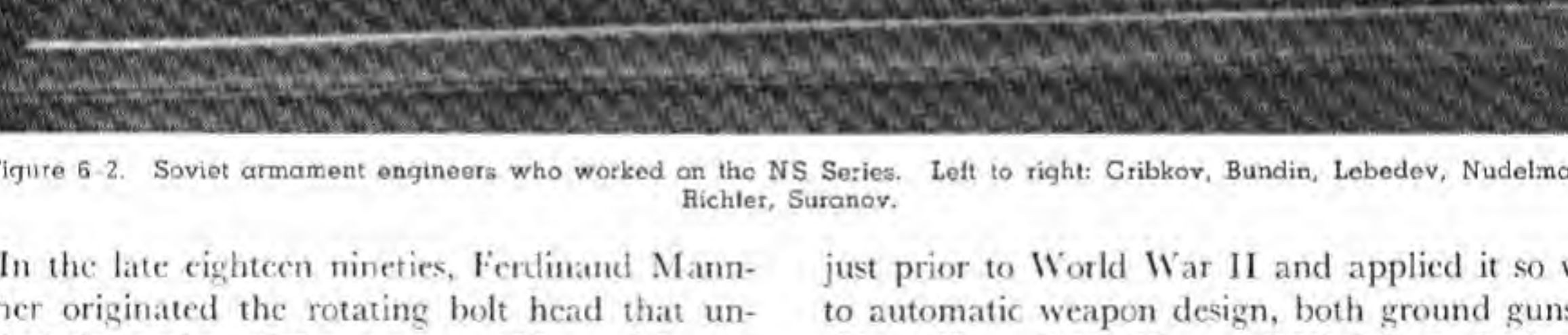


Figure 6-3. 37-mm NS Gun. Field stripped.

every major power. The family of Nudelman and Suranov guns was no exception.

In November 1943, an NS 37 gun fell into the hands of the Germans, who promptly put it under test at their Mauser plant. The detailed German reports on the weapon are available for studying the technical phase of the early guns.

The Germans had such a high respect for the original NS 37, they placed it on a chart and had it displayed prominently in ordnance establishments, in order that the armament personnel could familiarize themselves with the new design.

The NS 23 was designed by Nudelman for a cartridge having a 23-mm projectile. The designer retained the characteristics and the crude exterior of the NS 37, making improvements in the design in the process of scaling down.

The smaller caliber weapon was the last model to bear the official designation NS. The 37-mm cannon that appeared soon afterwards is referred to as the N 37, which implies, by Russian standards, that Nudelman had taken over the complete design of the weapon, even to the feed. The N 37, while employing a projectile of the same size as the earlier weapon, incorporates a drastic change in cartridge design, it being much shorter and having a smaller powder charge. The resulting muzzle velocity is 2700 feet per second. The rate of fire, however, is increased. The N 37 is far more refined in appearance, and the total weight with feeder and accessories is considerably less than the earlier version.

General Data for the NS 37

Caliber: 37-mm.
Rate of fire: 300 350 rounds/minute.
Muzzle velocity: 2,850 feet/second.
Gun length: 134¼ inches.
Gun weight: 375 pounds including feeder, charger, and external oil buffer.
System of operation: Short recoil.
System of locking: Rotating bolt head.
System of feeding: Pneumatic and spring.
Method of charging: Pneumatic.
Method of cooling: Air.
Barrel length: 90¾ inches.
Barrel removal: Not quick change.

General Data for the NS 23

Caliber: 23-mm.
Rate of fire: 600 to 700 rounds/minute.
Muzzle velocity: 2,850 feet/second.
Gun length: 78⅜ inches.
Gun weight: 121 pounds with all accessories attached.
System of operation: Short recoil.
System of locking: Rotating bolt.
System of feeding: Pneumatic.
Method of charging: Pneumatic.
Method of cooling: Air.
Rate control: None.
Barrel weight: 28⅞ pounds.
Barrel length: 57¼ inches.
Barrel removal: Not quick-change barrel.
Chamber pressure: 47,000 psi. (maximum).
Bore:
Number of grooves: 10.
Groove depth: 0.014 inch.
Groove width: 0.190 inch.
Pitch: 5° 12′ right, uniform.
Direction of twist: Right hand.
Form of twist: Concentric.
Method of headspace: Factory established.
Location of feed opening: Left side.
Location of ejection opening: Right side.
Across rifling lands: 0.910.
Across rifling grooves: 0.938.
Travel of projectile in barrel: 53 inches.

Description of the NS Series

Some features of this family of weapons deserve special note; one of these is the method whereby a smooth counter-recoil action is accomplished by oil

Figure 6 4. 37-mm NS Gun. Right side view.

Figure 6–5. 37-mm NS Gun. Underneath view, from right.

Figure 6–6. 37-mm NS Gun. Left side view.

Figure 6–7. 37-mm NS Gun. Hydraulic counter-recoil control cylinder.

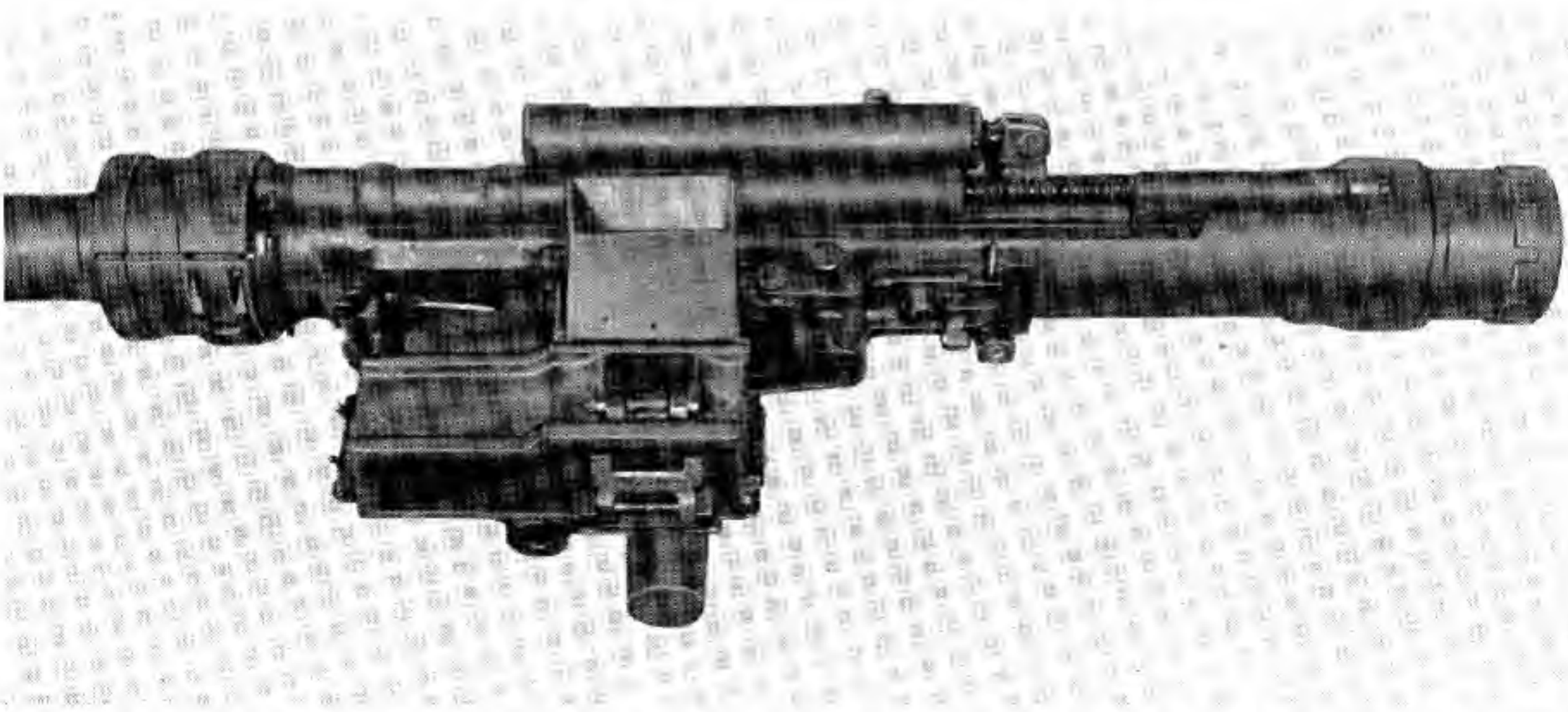


Figure 6–8. Close-up view of NS 37-mm gun from left. The shorter and thicker cylinder on top of the receiver is the hydraulic counter-recoil control. Link ejection chute is clearly visible on top of feed tray.

buffing without lowering the weapon's cyclic rate. Another good point is that some firing pin assemblies are so designed that the weapons can be converted from synchronized to inertia firing by the mere adding or taking away of components that go into the over-all assembly of the firing mechanism. The bolt, as it goes into the final movement to battery is rotated ¼ turn and locks by means of a lug on the bolt body following cams which are in the barrel extension. Simultaneously the firing pin, which is fixed to a portion of the aft end of the bolt body, is driven through the firing pin hole in the face of the bolt into the primer of the cartridge. This method is a common form of mechanics employed to produce percussion firing.

When necessary parts are assembled for synchronization, a firing pin spring and front sear are added. This arrangement permits the bolt to go all the way home and lock with the firing pin in a cocked position and to be released only when seared off by the trigger motor being actuated, causing a trigger bar to pivot up and release the sear. Each shot is fired at a predetermined time in the cycle since a mechanical obstruction has to be removed at each instant of discharge. This dual firing system also allows the weapon to be either front or rear seared as desired.

The bolt is energized by a compressed braided wire spring that is housed in the charging cylinder. Compressed air furnished to the gun through an electro-pneumatic valve operates both the built-in charger and feed system. When the retracting assembly is actuated, it simultaneously drives the bolt to the rear position and powers the feed pawl assembly, indexing the incoming round.

The feed slide assembly consists of three sets of spring loaded pawls so located that they index the incoming round while at the same time holding two other cartridges under control prior to positioning. The link employed is very similar to the German open type that was used by Rhinemetall-Borsig for the MK–108 Gun.

In the feedway, there is a chrome plated link stripper which separates the cartridge case from the links and then guides them between chromed surfaces to the link chute adapter. During the firing cycle, stripping is accomplished before the cartridges enter the main body of the receiver. The link chute adapter is secured to the top of the feedway by a hinge, an arrangement which allows instantaneous opening for visual inspection or maintenance. This piece is constructed of stainless steel which has been stamped or pressed and then spot welded, a type of construction known as "form

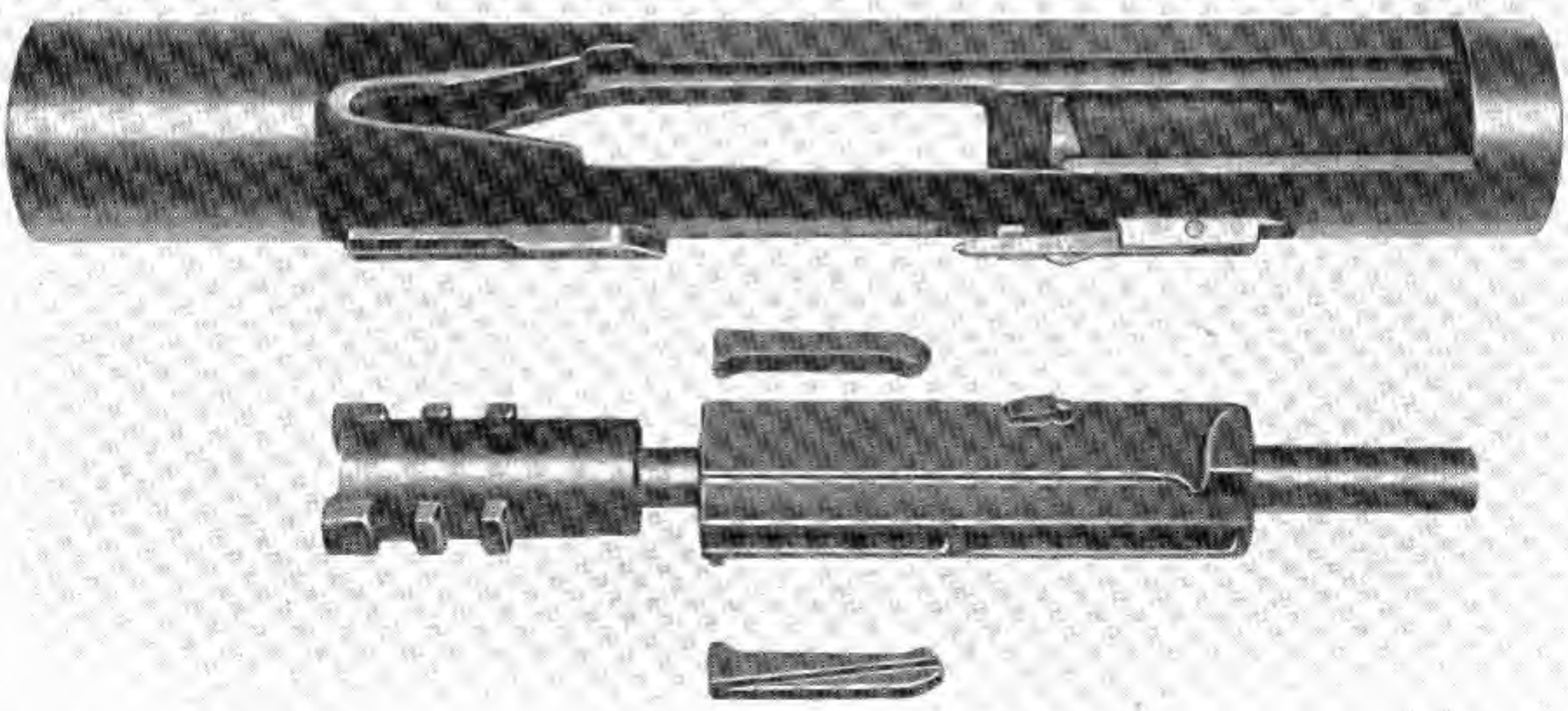


Figure 6–9. 37-mm NS Gun. Barrel extension and bolt.

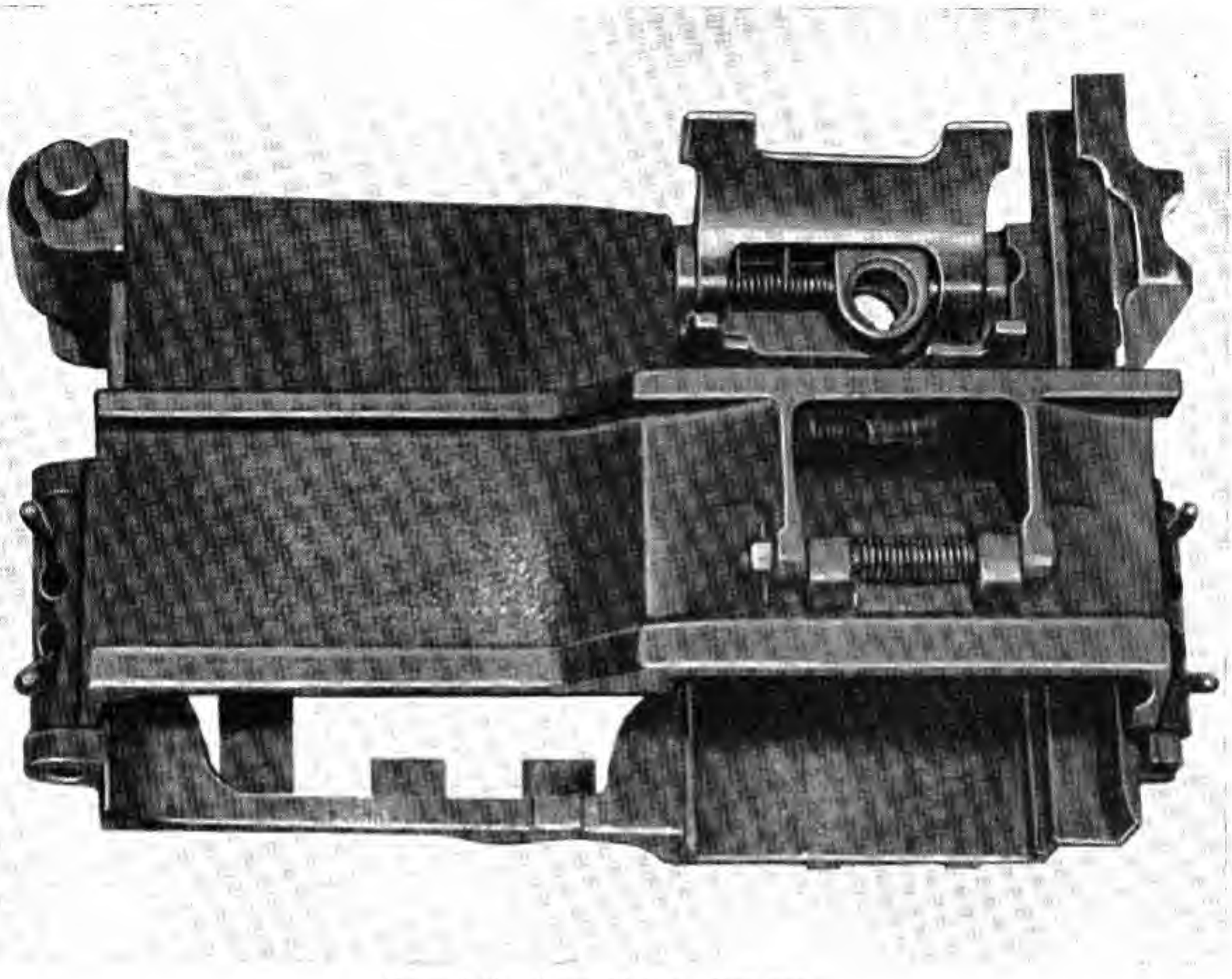


Figure 6-10. 37-mm NS Gun. Feed tray.

fitting." An extension of any reasonable length can be added to this piece; it is also made of stainless steel, fastened together by pin-locked piano wire hinges both fore and aft to make the necessary length to guide the expended links from the adapter to the ejection slots in the fuselage or wings of the plane.

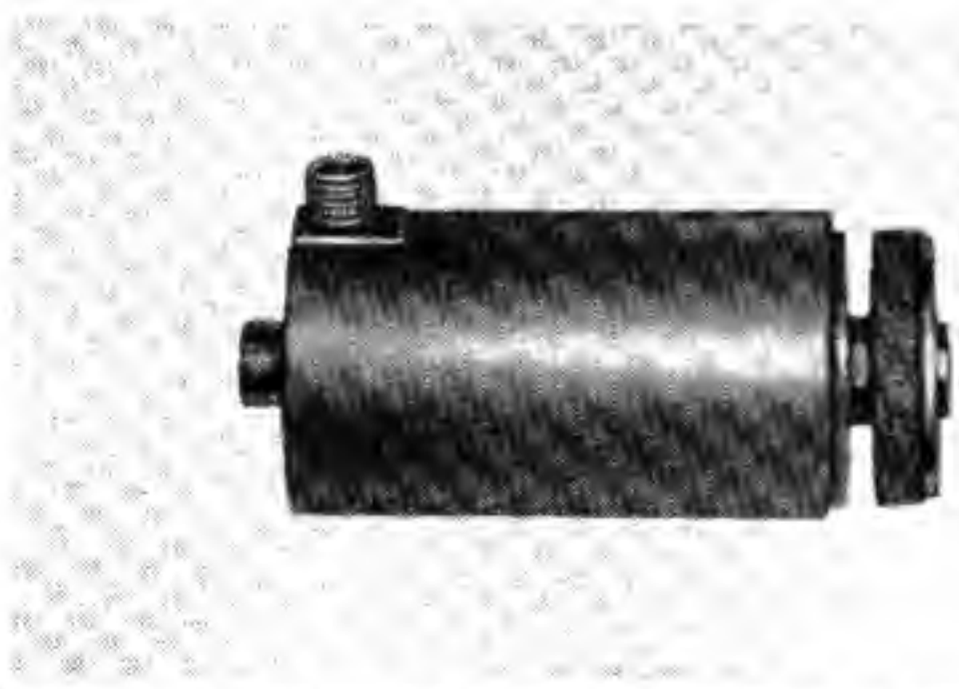


Figure 6-11. 37-mm NS Gun. Pneumatic feed pawl actuating cylinder.

When mounted to the airframe by a front and rear trunnion mount, the NS 23 has an adjustment for both azimuth and elevation. The front mount, which takes the major impact during firing, weighs 4 pounds 3 ounces and is provided with four mounting holes. The entire assembly consists of a hinged split ring with toggle bolt that fits snugly around the adapter at the forward end of the receiver. A sort of ball and socket joint allows movement necessary for bore sighting. The rear mount is a stud held in a solid metal block to which is attached a threaded post. By positioning the latter part and then moving the block to the desired degree away from the axis of the post, both vertical and horizontal adjustment can be accomplished.

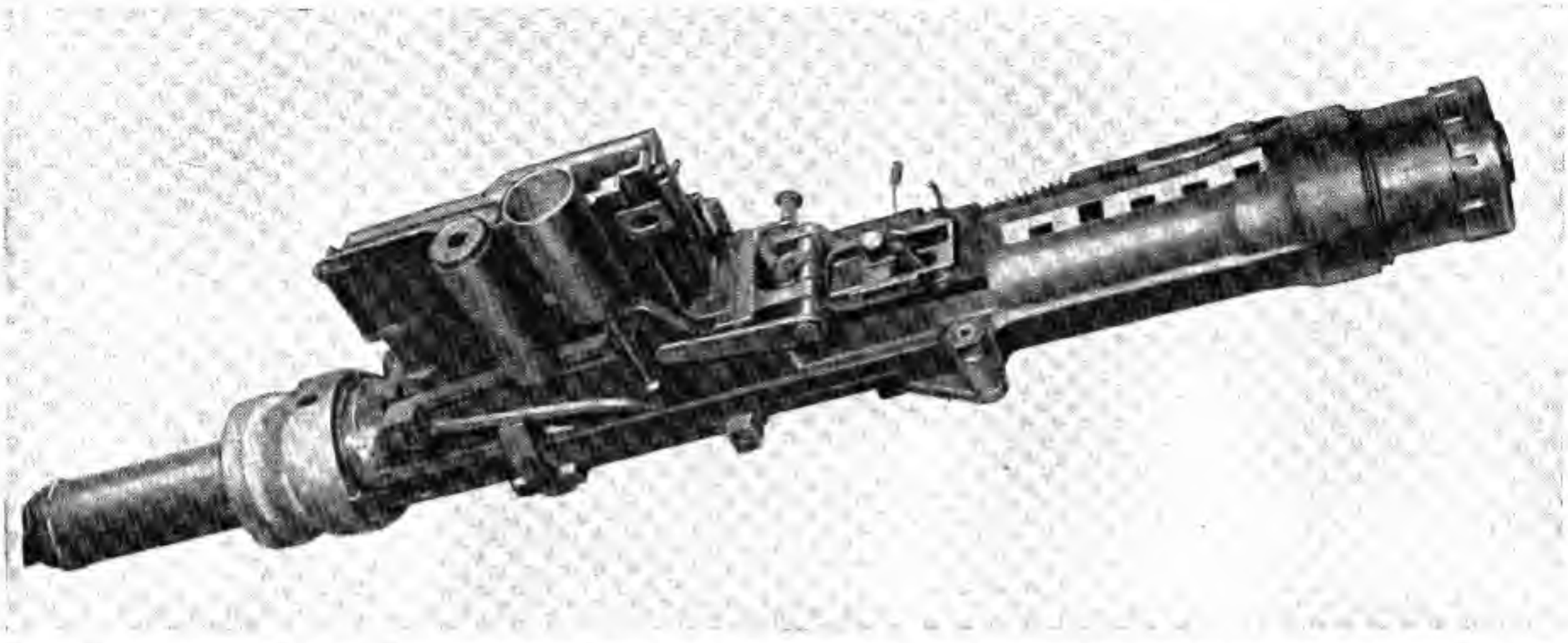


Figure 6–12. 37-mm NS Gun. View underneath feed from left of receiver. The larger of the circular recesses on the edge of feed tray is the seat for the pneumatic actuator (see fig. 6 11).

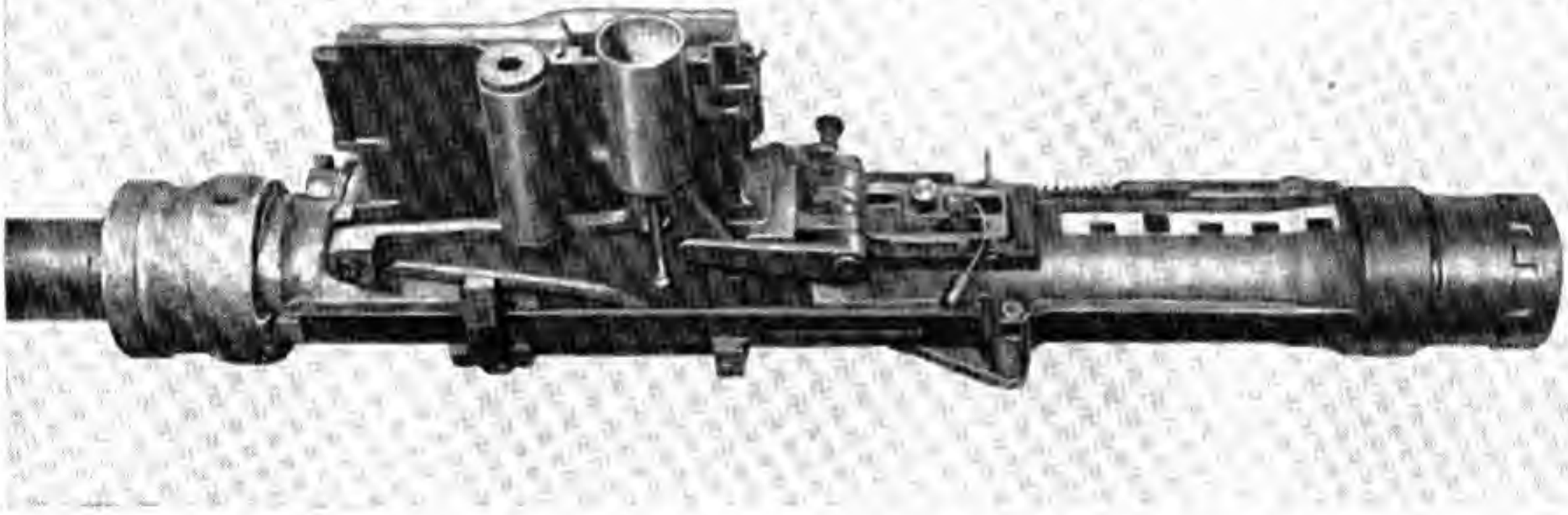


Figure 6–13. 37-mm NS Gun. View underneath feed from left of receiver. The smaller recess under the feed tray houses the feed cam return spring.

The 23-mm synchronized gun is mounted differently than the un-synchronized gun. The forward support consists of trunnions integral with a ring which is assembled to the front of the receiver. The rear support consists of a hinged clamp which is fastened around the rear of the receiver.

When the NS 37 was first introduced, it was mounted in the YAK–9 fighter plane and was bolted directly to the cylinder head of the engine.

It was later installed in the Stormovik, but in this case, it was mounted underneath the wings. This position did not prove satisfactory as the terrific impact from recoil made the plane unmanageable if during a burst of normal length one gun happened to malfunction. Failure to recognize the necessity of keeping plane design in step with weapon development resulted also in structural failures at other securing points.

The earlier method of fastening the weapon to the engine's cylinder block had another weakness; the unyielding engine frame caused cracked cylinder heads and mounting lugs. The Soviet engineers tried to overcome this by fashioning an adjustable mounting yoke that was rigidly fixed to the airframe. This later modification to the system of mounting supported the back plate buffer, but in

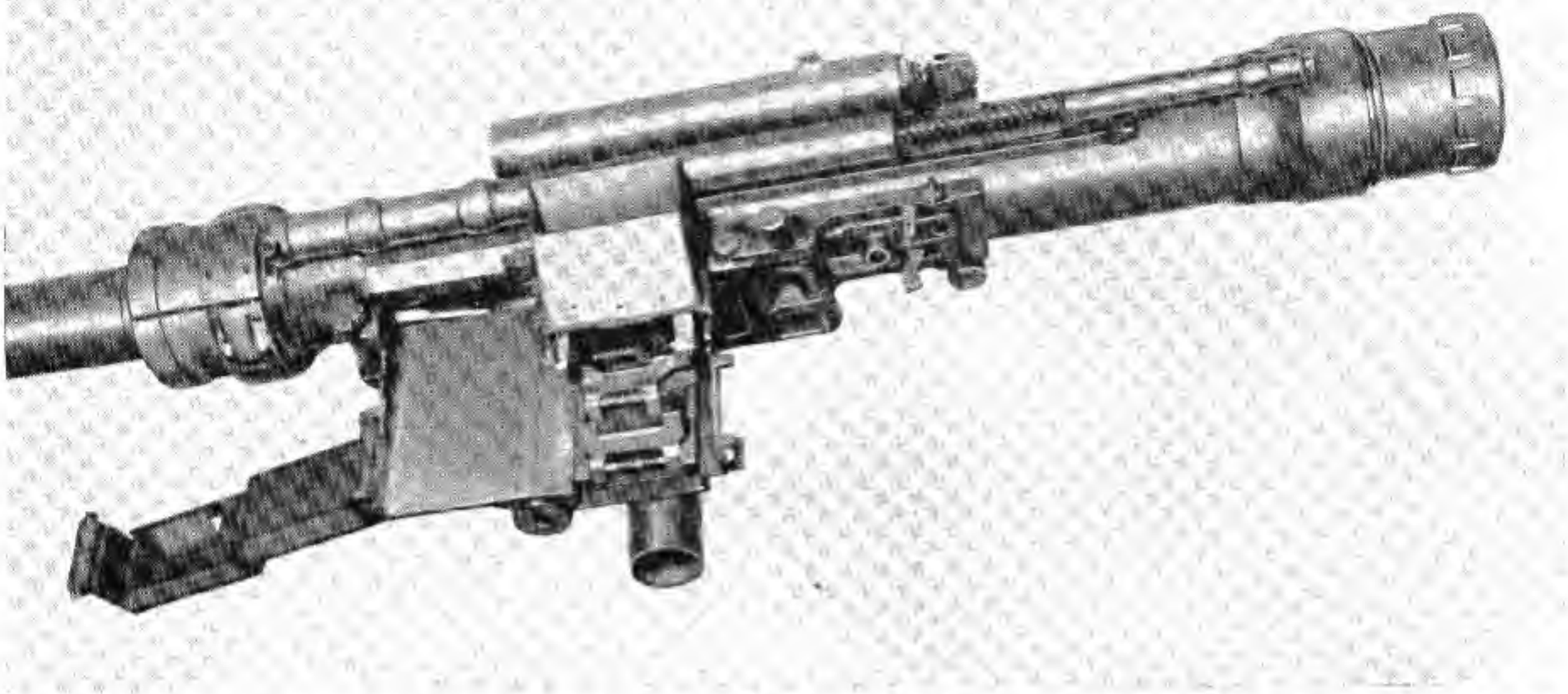


Figure 6–14. Close-up of feed-tray of 37-mm NS Gun. Feed cover which carries the belt holding pawl has been hinged to the left, exposing the belt-moving pawls.

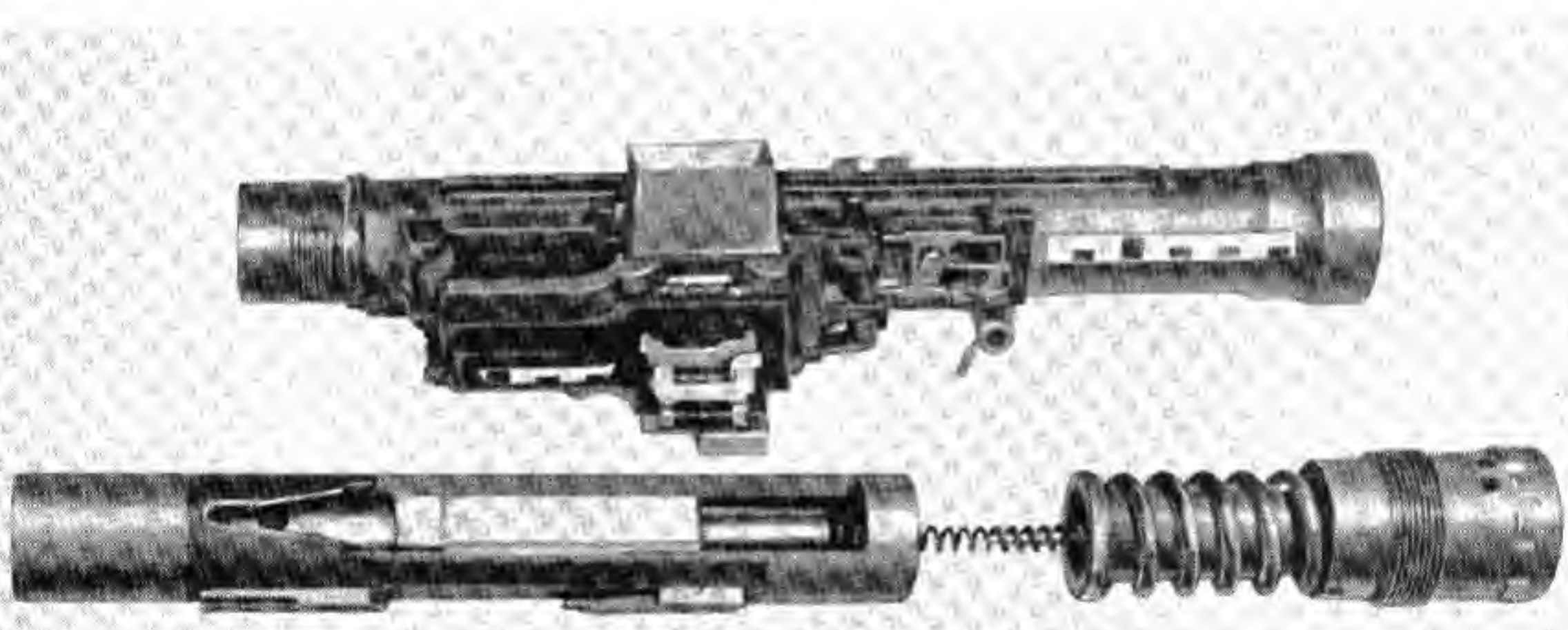


Figure 6–15. Receiver group of the 37-mm NS Gun. In the foreground is the barrel extension (which carries the bolt) and to the right of it, the recoil buffer.

Figure 6–16. 37-mm NS Gun. Barrel and barrel extension, assembled.

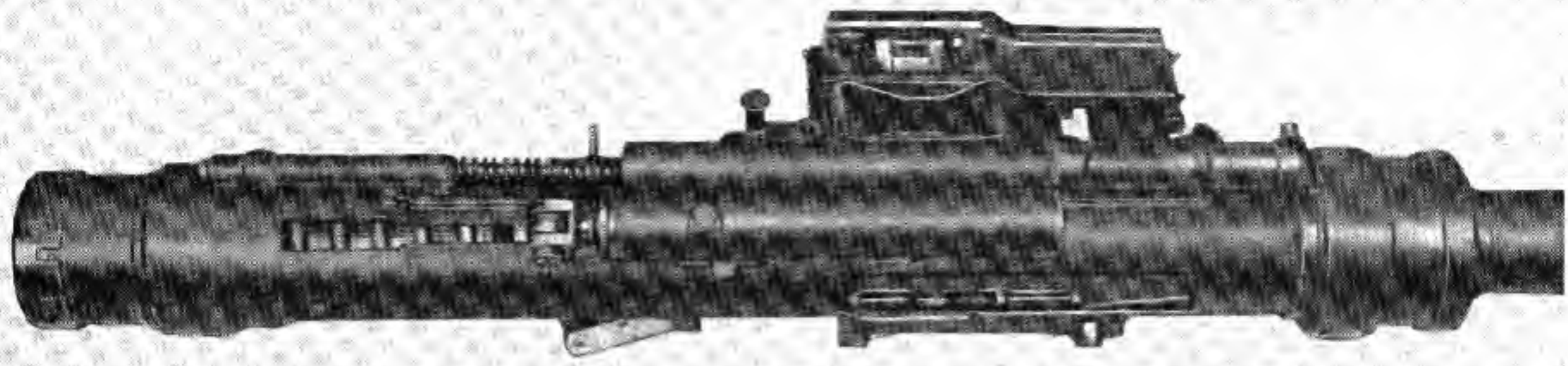


Figure 6-17. Close-up view of 37-mm NS Gun from right. The long thin cylinder on top of the receiver is the pneumatic charger.

Figure 6-18. 37-mm NS Gun. Receiver Group. In the foreground is the barrel extension (left) and bolt group (right).

order to make this change, it was found necessary to move the pilot's seat position slightly farther to the rear. A male and female coupling type of mounting bracket was also fastened to the cylinder block and had splines cut in its body, to allow for the recoil movement of the gun. The forward part of the barrel was supported by a moderately close fitting sleeve or bushing that was housed in the hollow propeller hub.

The ammunition is carried in the plane in cans of the removable type. They are made of aluminum, weigh 9 pounds 2 ounces each, and come equipped with two small leather handles for carrying. The inside dimensions of the cans are 16 x 10½ x 8½. The back side of the container has a large hinged door, designed to facilitate loading and stacking of ammunition. One of the most distinguishing features about the smaller guns is the enclosed buffer, whereby the heavy peculiarly designed spring is housed inside the receiver, leaving the rear end of the gun minus the conventional protrusion that is on practically every machine gun that uses a mechanical means for buffing the recoiling parts.

The high muzzle velocity of 2,850 feet/second of the NS 37 gave the projectile a high penetration of armor when impact was at an angle that would not cause ricocheting.

The NS 37 showed the Russians that they were on the right track in turning to the short recoil principle for operational energy. It also pointed out that the weapon would have to be refined if it was to serve a useful purpose in the future. Before long another version of automatic aircraft cannon made its appearance, the NS 23.

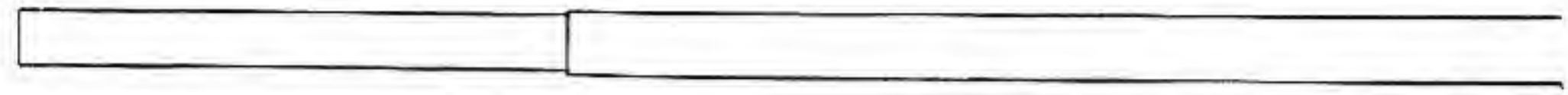


Figure 6–19. Assembly views of a Soviet 23-mm NS Cannon.

The NS 23 can be mounted in either the wing or fuselage. The latter mounting is more popular but necessitates synchronization, which causes a lower cyclic rate. The plane in which this gun is usually mounted will accommodate only three, or at the most four, guns. The fire power is, accordingly, inadequate for air-to-air combat. The gun is effective in close ground support, especially against armored vehicles.

The NS 23 aircraft cannon was used quite extensively with little or no change made in its construction; however, just as soon as the end of hostilities allowed them to do so, the Russians began an overall refinement program on both the 23-mm and 37-mm versions. While post-war models did not deviate basically from the original design, there have been refinements in these later versions.

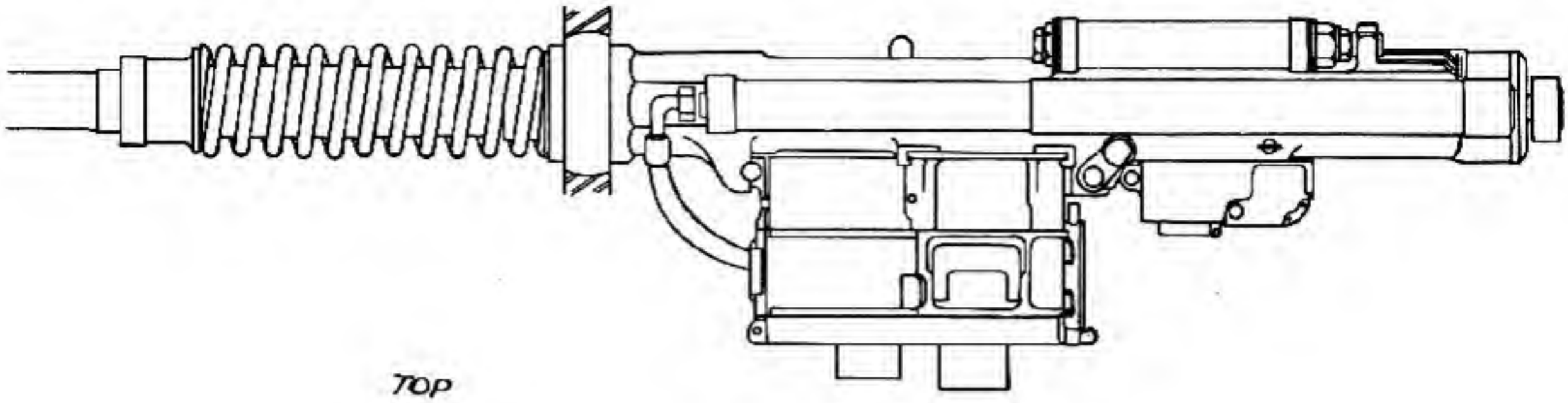
One of the main changes was to do away with the synchronizing of the firing mechanism. This did much to simplify construction of the bolt and its components. The rate of fire was stepped up. Also, every possible way to reduce the weight was attempted and so successful were the Soviets in this undertaking, that the post-war version designed for their jet fighter is approximately 33 pounds lighter than the type installed in the YAK–9, close air support plane.

Cycle of Operation for the NS Series

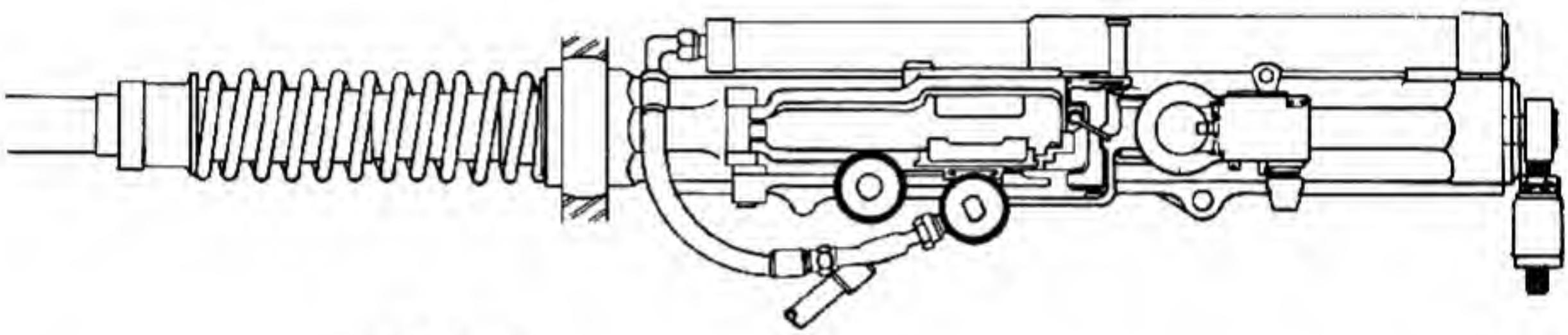
The cycle of operation for all guns of this series is similar and the following explanation which relates specifically to the 23-mm NS would apply to any of the other Nudelman designs.

Charging is accompilshed pneumatically through a system involving two cylinders, one to move the bolt rearward against its drive spring and one to charge the feeder springs. Both cylinders receive air under pressure simultaneously through a solenoid-controlled valve.

During charging, air under pressure acts on the charger piston assembly in the drive spring housing. Under this force the piston moves rearward, causing the drive spring guide to compress the drive spring. The bolt body is attached to the drive spring guide by a lug, causing the bolt body to move rearward with the drive spring guide. Simultaneous motion of the feeder cam plate depresses the bolt pawl allowing the bolt body to continue rearward under the force of the air acting on the charger piston assembly. The rearward motion of the bolt body rotates the bolt head lugs out of engagement with the recesses in the barrel extension, thus unlocking the bolt and allowing the air pressure to move the bolt completely rearward to the seared position.



TOP



LEFT SIDE

Meanwhile air under pressure enters the charger cylinder for the feeder exerting force on the charger piston assembly for the feeder. This force causes the feeder cam plate to be lifted, thus compressing the feeder springs, and moving the feeder slide outward. The feeder pawls are forced upward against their springs by the rounds in the ammunition belt during this motion. The rounds in the ammunition belt are held stationary during the outward motion of the feeder slide by the action of the holding pawl in the feeder cover plate. After the feeder slide and the bolt have completed their travel under air pressure, the solenoid-controlled valve reverses, venting the air on the high-pressure side of each piston. This causes the drive spring to move the bolt forward until it is caught by the sear, and causes the feeder springs to move the feeder slide in. The feeder pawls, which in the outward position moved up behind the rounds in the belt under the force of their springs, pull the belt into the gun and position a round in the T-slot in the face of the bolt. The feeder cam plate releases the mechanical sear at the end of its stroke, causing the bolt to be held rearward only by the solenoid-controlled trigger sear.

To load the gun the feeder cover plate and the link stripper assembly are removed. The link of the leading round in the belt is engaged with the link stripper and the link stripper assembly is reassembled. The feeder cover plate is then installed. After charging twice, the gun will fire upon release of the solenoid-controlled trigger sear.

In this ready state the feeder springs are expanded, and the cartridge is positioned in the T-slot in the face of the bolt. When the solenoid is actuated by the firing switch, the sear releases the bolt and the drive spring sends it home against the barrel, to chamber the round. The head of the bolt strikes the base of the barrel and stops. The body of the bolt continues forward, and a stud on the bolt head extension follows a cam groove in the bolt body, causing the head of the bolt to be rotated so that the locking lugs on the bolt head engage recesses in the barrel extension, thus locking the bolt to the barrel extension. Rebound of the bolt body is prevented by a spring-loaded pawl which snaps into a recess in the barrel extension.

As the bolt body nears the end of its forward

Figure 6–20. 37-mm NS Gun. Recoil buffer assembly.

travel, $\frac{7}{16}$ inch after the bolt head is locked, the firing pin is brought into contact with the primer, firing the round.

When the round fires, reaction against the bolt head causes the bolt assembly, barrel extension, and barrel to move rearward, since the bolt is locked to the barrel extension. After about $\frac{29}{32}$ inch of recoil travel, the accelerator, pivoted in the receiver, starts to move the bolt body rearward at an increased velocity, causing it to cam the bolt head locking lugs out of engagement with the recesses in the barrel extension. This is possible because the pawl which prevents the bolt body from rebounding is disengaged from the barrel extension during recoil by the camming action of an intermediate lever between the receiver and the pawl. (During charging this pawl is disengaged by the motion of the feeder cam.) The unlocked bolt continues rearward until it strikes the buffer spring. It rebounds from the buffer, travels forward a short distance, and is stopped by a mechanically-operated sear, which is controlled by the feeder cam. This sear is side by side in the same housing with the electrical sear; either of them can hold the bolt in the rearward position. In the seared position the T-slot in the head of the bolt lines up with a T-slot in the feeder, which acts as a guide for the cannelure of the cases being fed.

As the barrel extension recoils, a shoulder on its side lifts the cam plate of the feeder, compressing the feeder springs. After the barrel extension has recoiled $2\frac{13}{16}$ inches, the feeder springs are compressed, and a spring-loaded latch, pivoted in the receiver moves under the feeder cam plate to hold these springs compressed. The barrel extension continues rearward a short distance further, until all of its remaining kinetic energy has been absorbed by the helical recoil spring. The total recoil travel of the barrel extension is about $3\frac{1}{4}$ inches. At the rear of the recoil position, the energy stored in the main recoil spring acts to return the barrel and barrel extension to battery.

The counter-recoil buffer starts to slow the counterrecoiling parts when they are $1\frac{13}{16}$ inches from the battery position, reducing the shock of stopping these parts.

When the barrel extension is 1⅛ inches from battery on its counter-recoil stroke, a cam on its side releases the latch holding the feeder cam plate, which allows the feeder springs to expand. The expansion of these springs operates the feeder slide, which forces a new round against the empty case held in the T-slot on the face of the bolt head (aligned by the scar) and pulls in the ammunition belt. This causes the empty case to be pushed off the face of the bolt and ejected through the side of the receiver, while the new round is positioned in the T-slot in the face of the bolt head. The links are stripped from the rounds in the feeder by the link stripper assembly and discharged through the bottom of the feeder. When the feeder cam plate is ⅛ inch from completing its feed stroke, it actuates a pin in the receiver which causes a stop pawl to be moved out into the path of the round being fed, causing it to stop in the proper position on the face of the bolt. A spring-loaded pin in the face of the bolt acts to retain the cartridge on the face of the bolt during ramming.

As the feeder cam completes its stroke, it releases the mechanical sear holding the bolt rearward and allows the drive spring to return the bolt to battery, initiating another cycle.

The synchronized 23-mm NS Gun probably fires the same ammunition and has the same performance characteristics as the free-firing gun, except that in synchronized firing, its cyclic rate would be slightly lower. The physical proportions and weights of the two guns are nearly identical.

Summary

The advantages and disadvantages peculiar to this design are general throughout the series but the following points apply particularly to the 23-mm guns.

Advantages. The advantages of this weapon appear to be as follows.

a. Mechanical ruggedness. It is probable that part breakages are rare in this weapon. The working parts are sturdy and apparently stressed only to reasonable levels.

b. Dependability. The method of feeding is positive throughout. Since the empty case is pushed out by the incoming round which, in turn, is positively positioned into the T-slots in the face of the bolt while the bolt is seared, feeding jams should be rare. Extraction and ejection are gentle and positive. In-line ramming contributes to dependability.

c. Low silhouette. This feature is of significance in fixed and flexible aircraft gun installations demanding minimum gun profiles.

d. Relatively high belt pull. It is probable that belts of considerable length can be fed without ammunition boosters.

e. Reliability. Operation of the weapon should be reliable under a wide range of climatic conditions.

Disadvantages. The disadvantages of the weapon are as follows: low cyclic rate, moderate muzzle velocity, rear scar or bolt after each round during automatic fire. Although this feature makes possible the positive feed and ejection feature and may be justified on this basis, it is an unusual principle in automatic weapons, and does reduce the cyclic rate.

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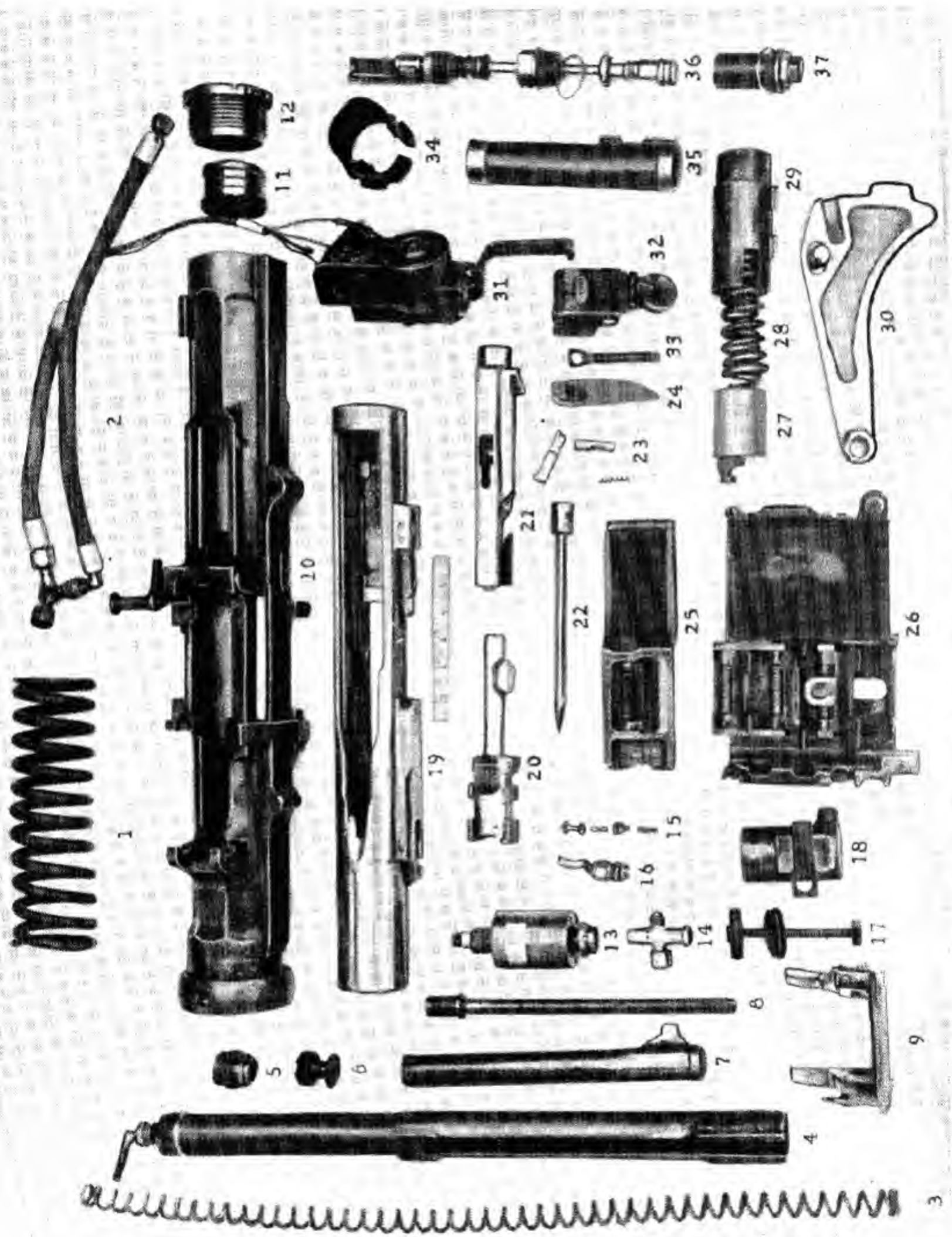

Figure 6-21. 23-mm NS Cannon, dismantled. The barrel is not shown.

1. Recoil spring.
2. Charger hose assembly.
3. Driving spring.
4. Driving spring housing.
5. Driving spring cap.
6. Charger piston assembly (bolt).
7. Driving spring sleeve.
8. Driving spring guide.
9. Link stripper assembly.
10. Receiver assembly.
11. Buffer spring.
12. Buffer housing.
13. Charger solenoid.
14. Charger valve housing.
15. Charger valve internal components.
16. Air connector.
17. Charger piston assembly (feeder).
18. Charger cylinder (feeder).
19. Barrel extension.
20. Bolt head.
21. Bolt body.
22. Firing pin assembly.
23. Bolt pawl components.
24. Accelerator.
25. Feeder cover plate.
26. Feeder assembly.
27. Feeder spring cap.
28. Feeder springs (inner and outer).
29. Feeder spring housing.
30. Feeder cam plate.
31. Sear assembly.
32. Sear cover.
33. Sear mounting pin.
34. Recoil spring retainer nut.
35. Counter-recoil buffer housing.
36. Counter-recoil buffer piston.
37. Counter-recoil buffer cap.

Figure 6-21.—Continued

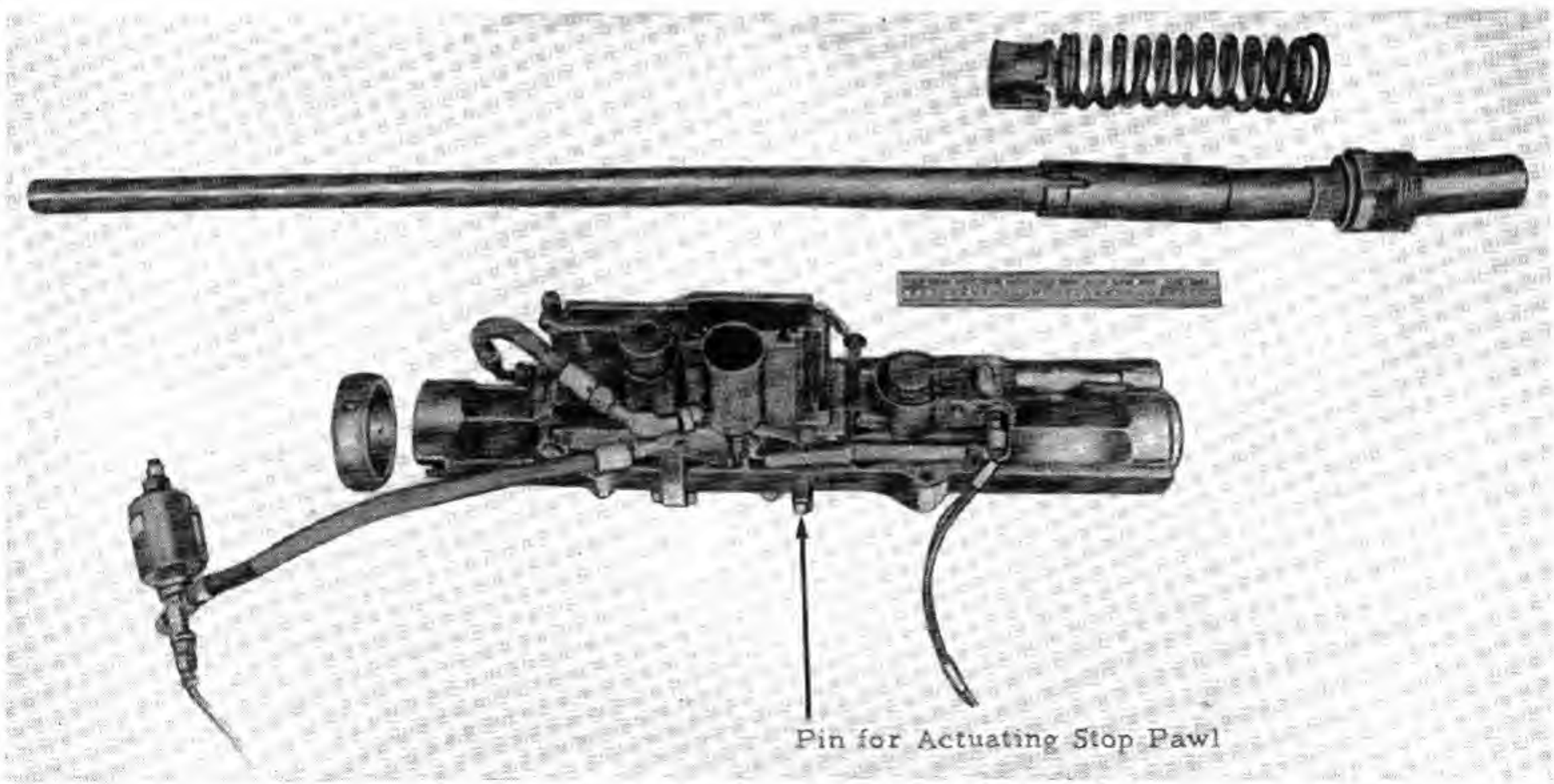

Figure 6-22. The two major assemblies of the 23-mm NS Gun.

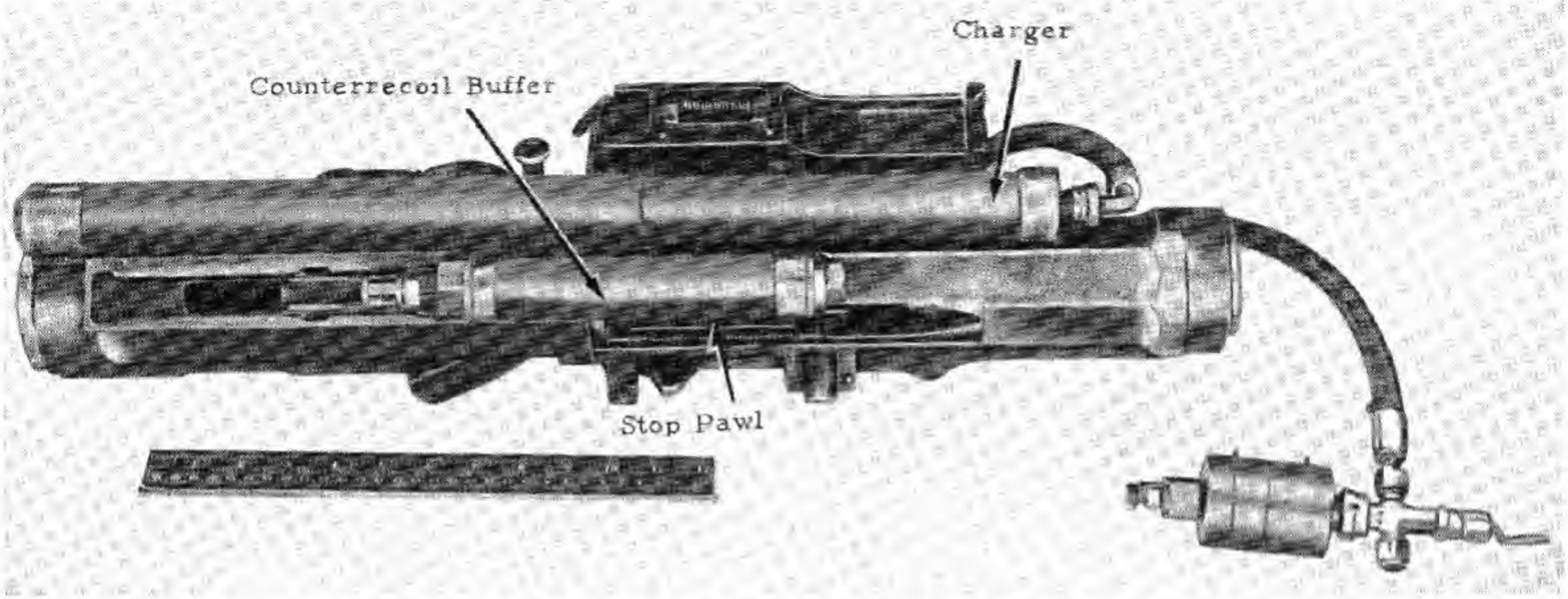

Figure 6–23. Receiver Assembly of 23-mm NS Gun, showing charger, counter-recoil buffer, and charger solenoid valve.

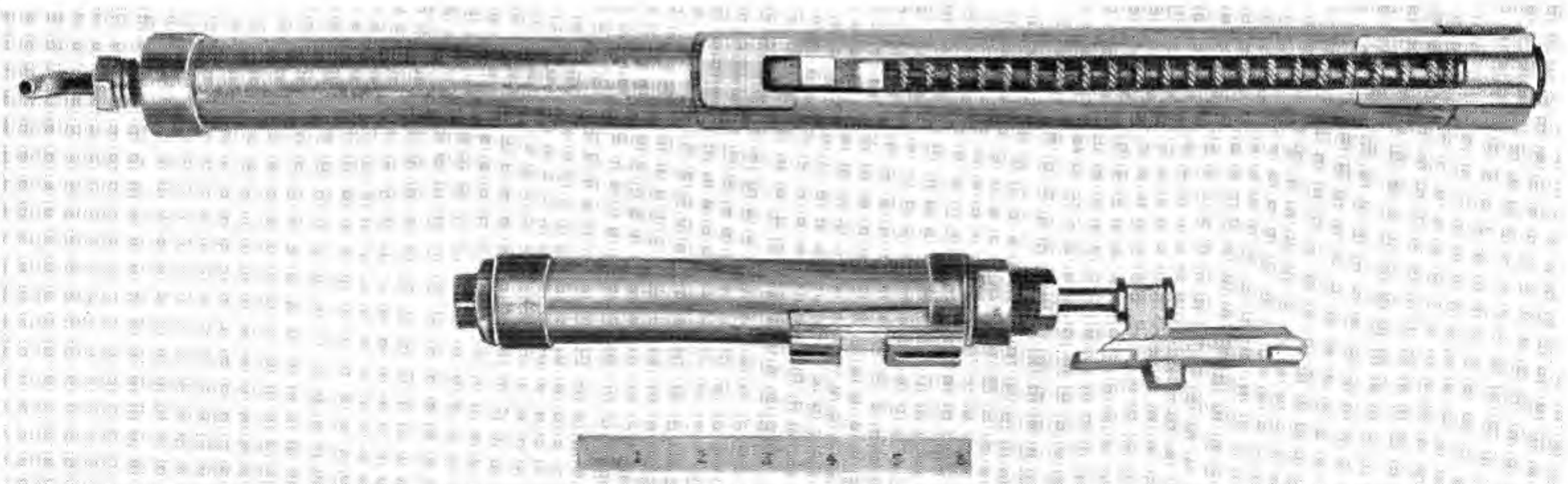

Figure 6–24. Charger and counter-recoil buffer for 23-mm NS Gun.

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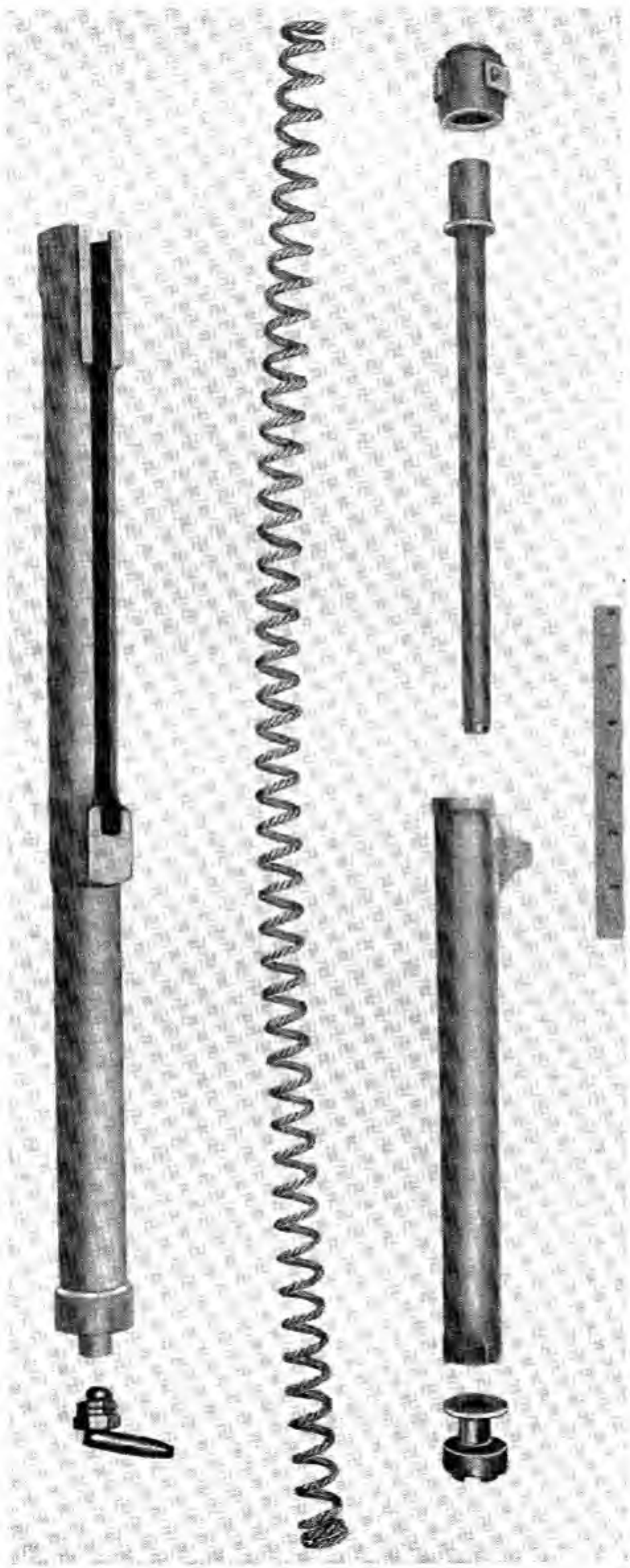

Figure 6 25. 23-mm NS Gun. View of disassembled charger.

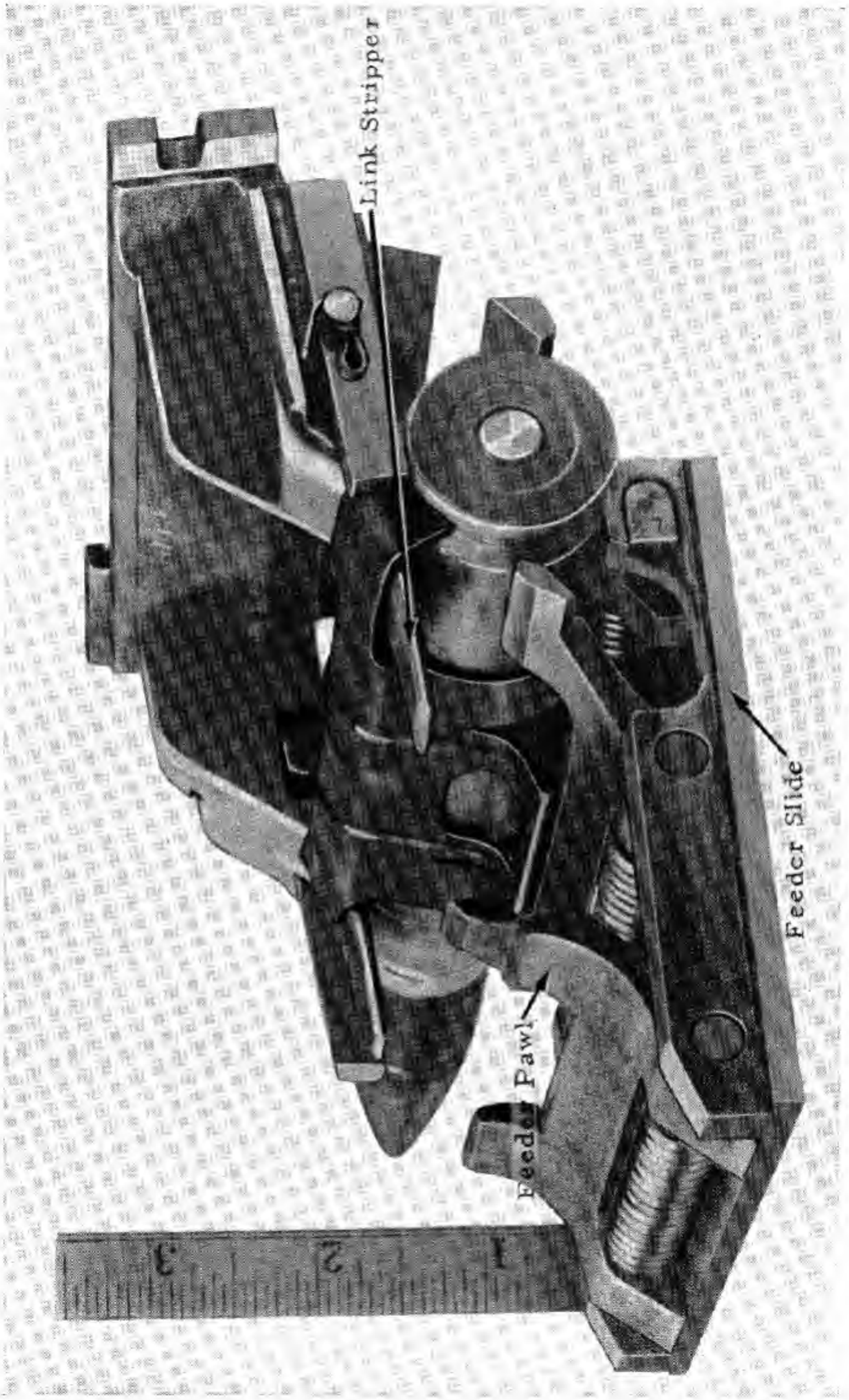

Figure 6–26. Feeder slide and link stripper for 23-mm NS Gun.

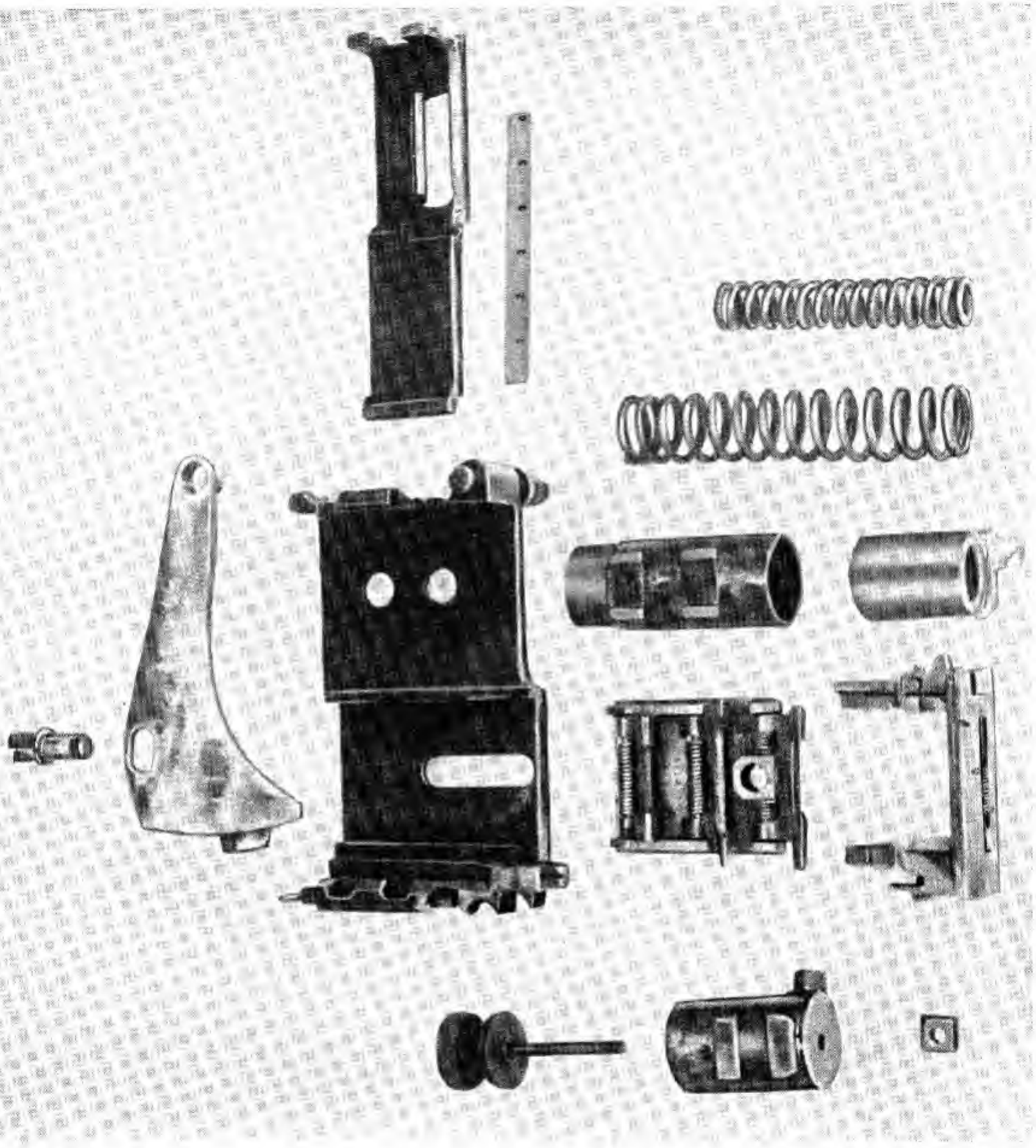

Figure 6-27. View of disassembled feeder for 23-mm NS Gun.

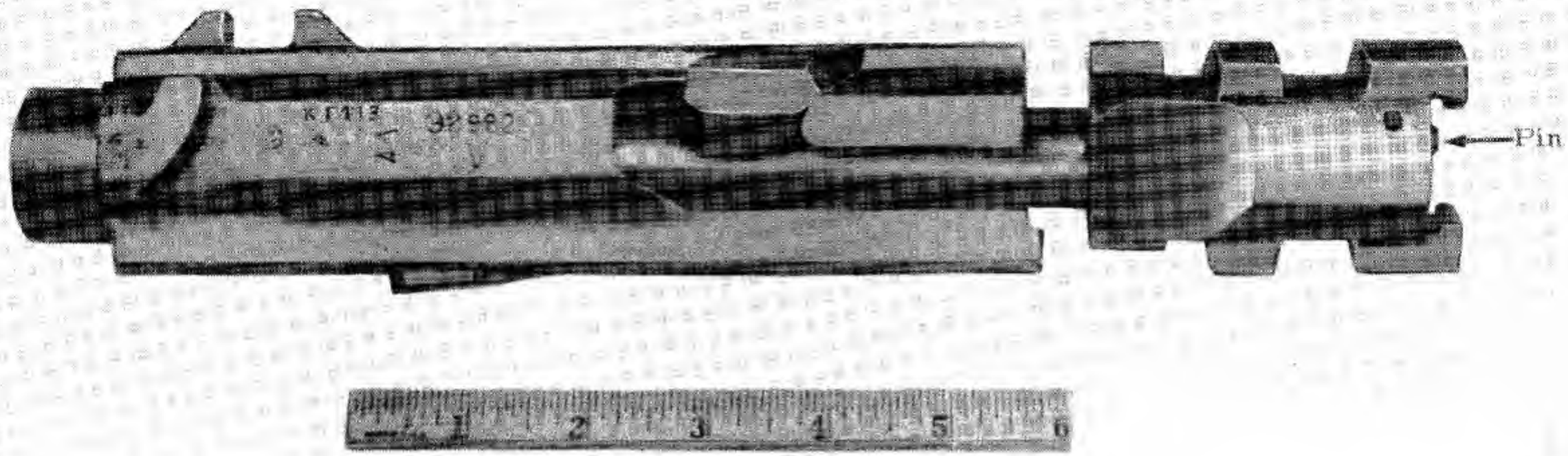

Figure 6-28. Bolt assembly for 23-mm NS Gun.

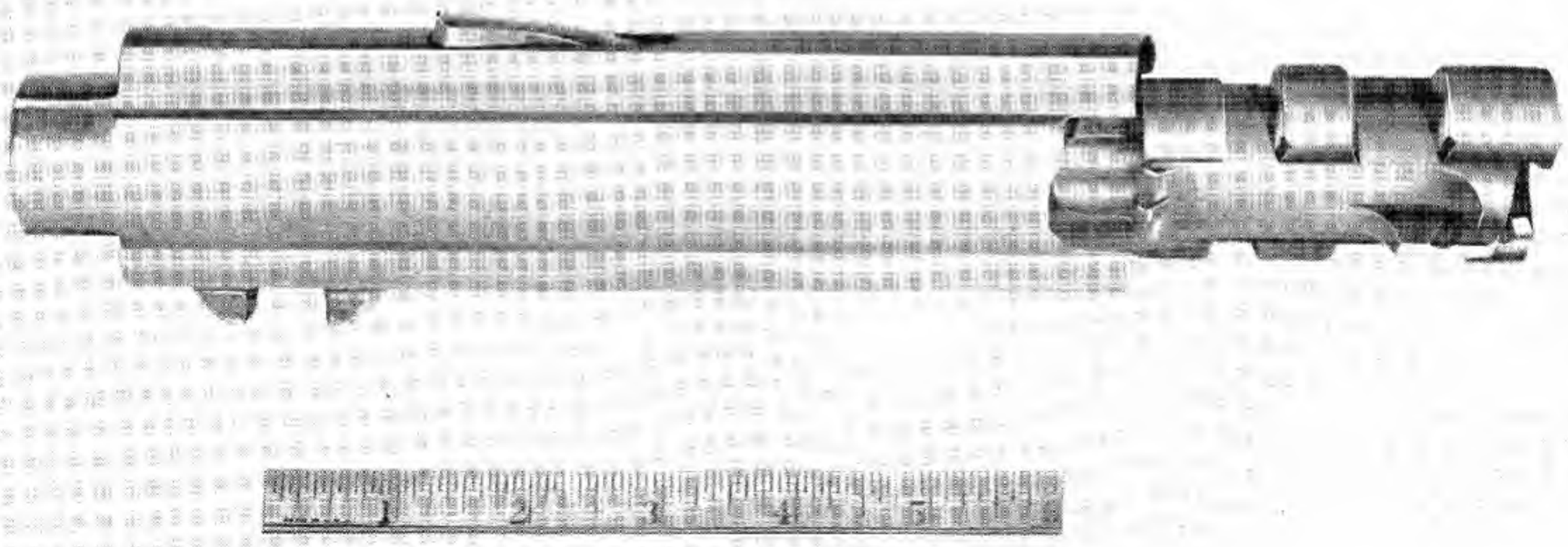

Figure 6-29. Another view of bolt assembly for 23-mm NS Gun.

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Figure 6-30. View of disassembled bolt for 23-mm NS Gun.

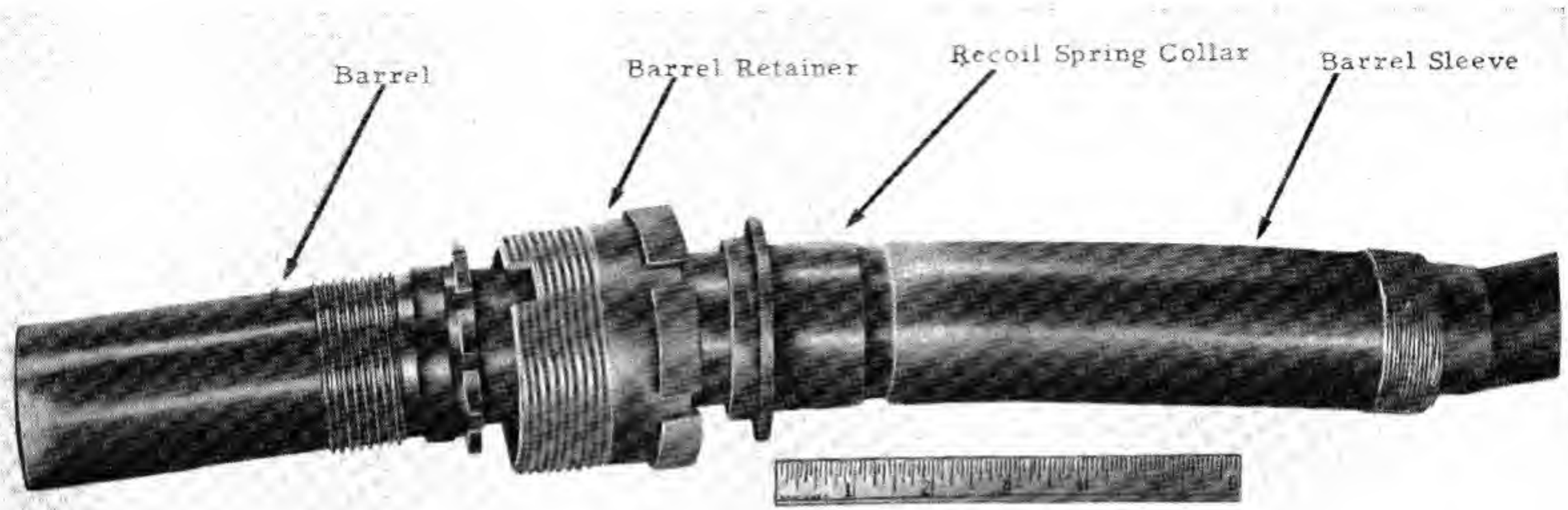

Figure 6 31. Barrel, barrel sleeve, recoil spring collar and barrel retainer for 23-mm NS Gun.

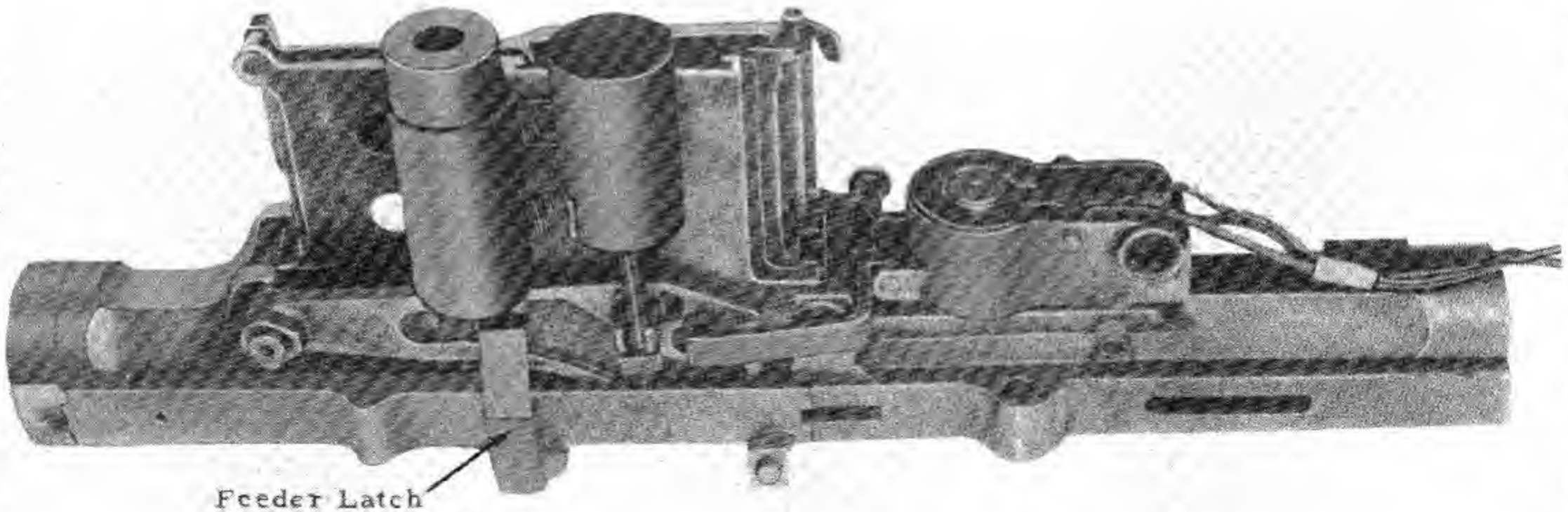

Figure 6-32. Receiver assembly of 23-mm NS Gun showing feeder cam plate and mechanical sear linkage.

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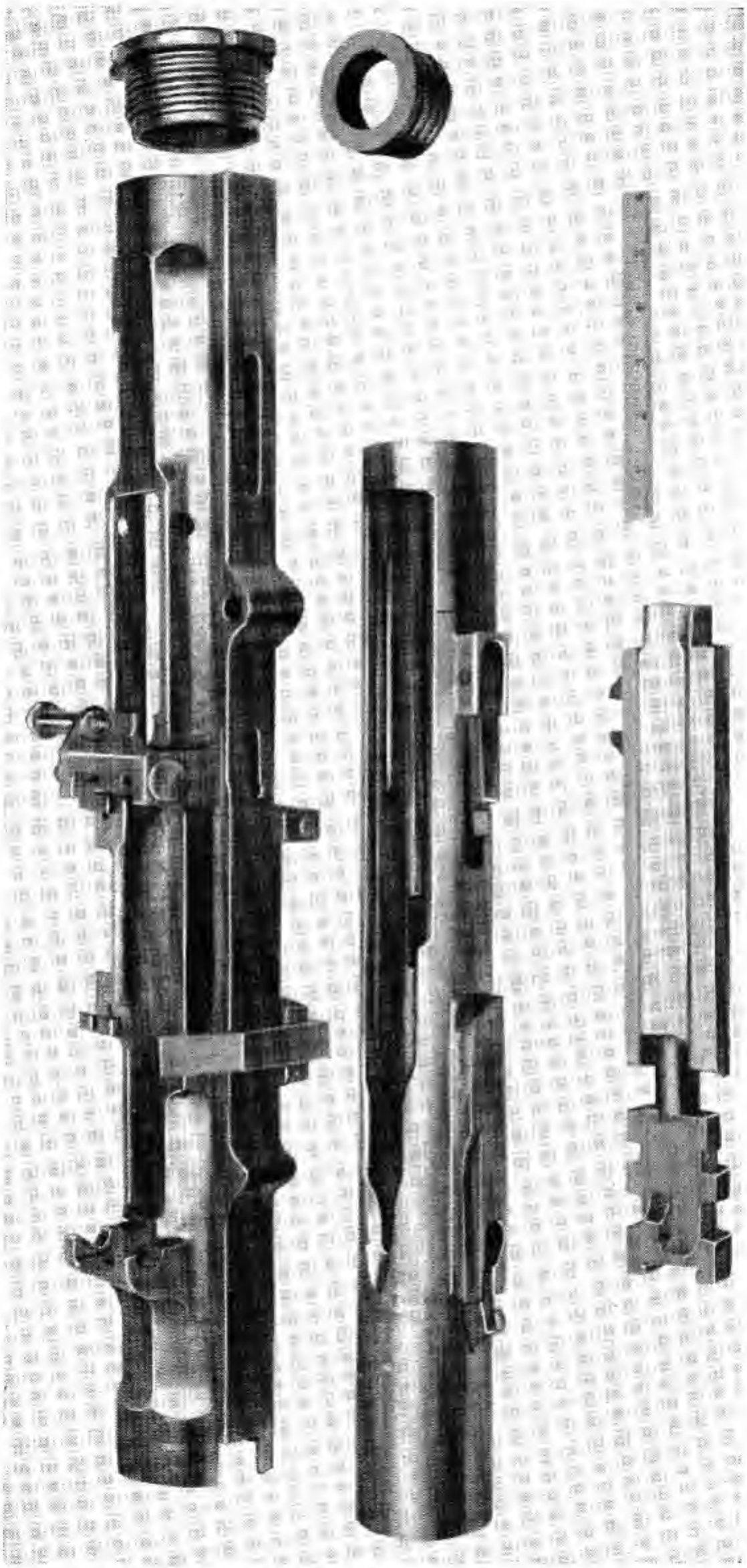

Figure 6-33. Receiver, buffer, barrel extension and bolt for 23-mm NS Gun.

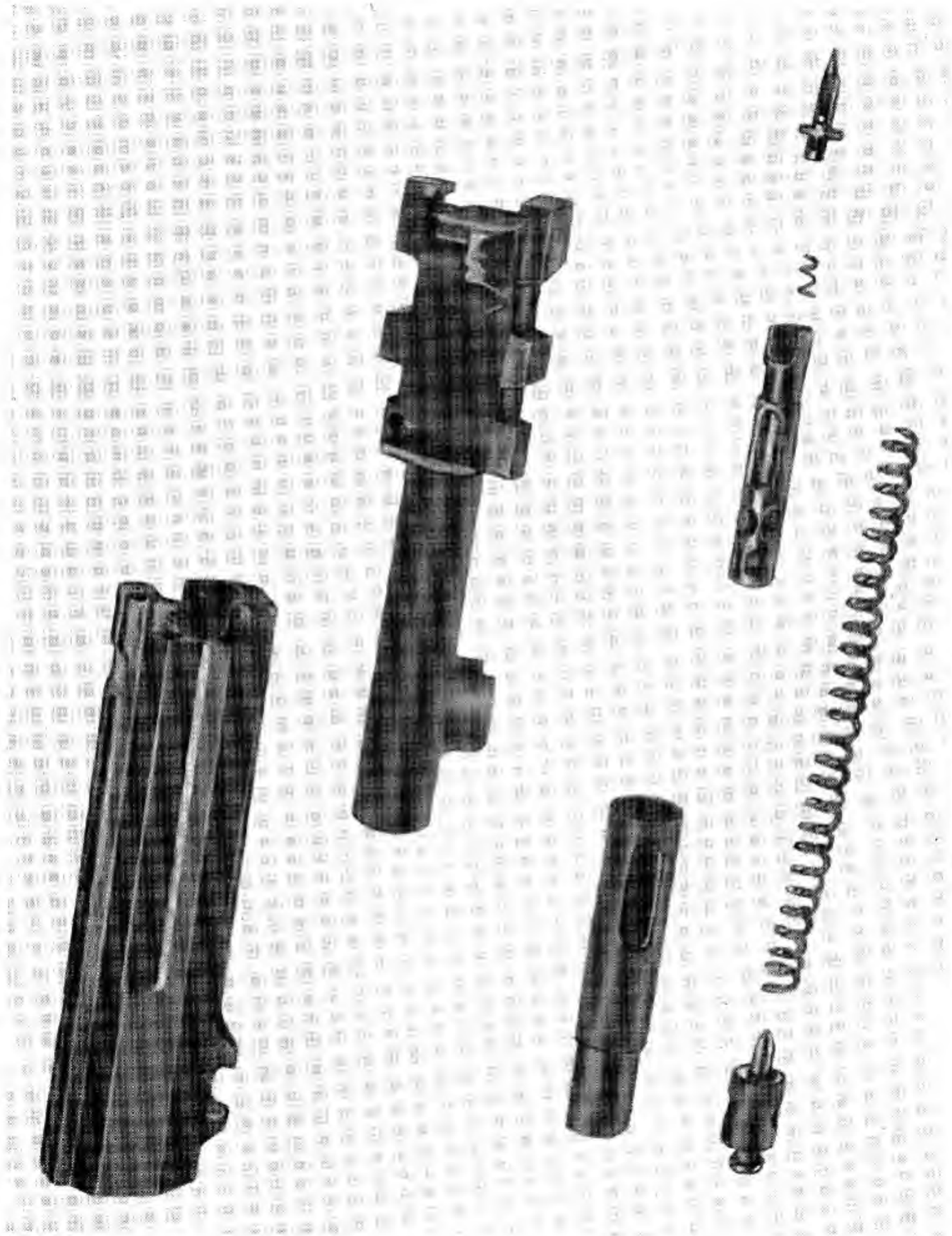

Figure 6-34. Synchronized version of 23-mm NS Gun. View of disassembled bolt.

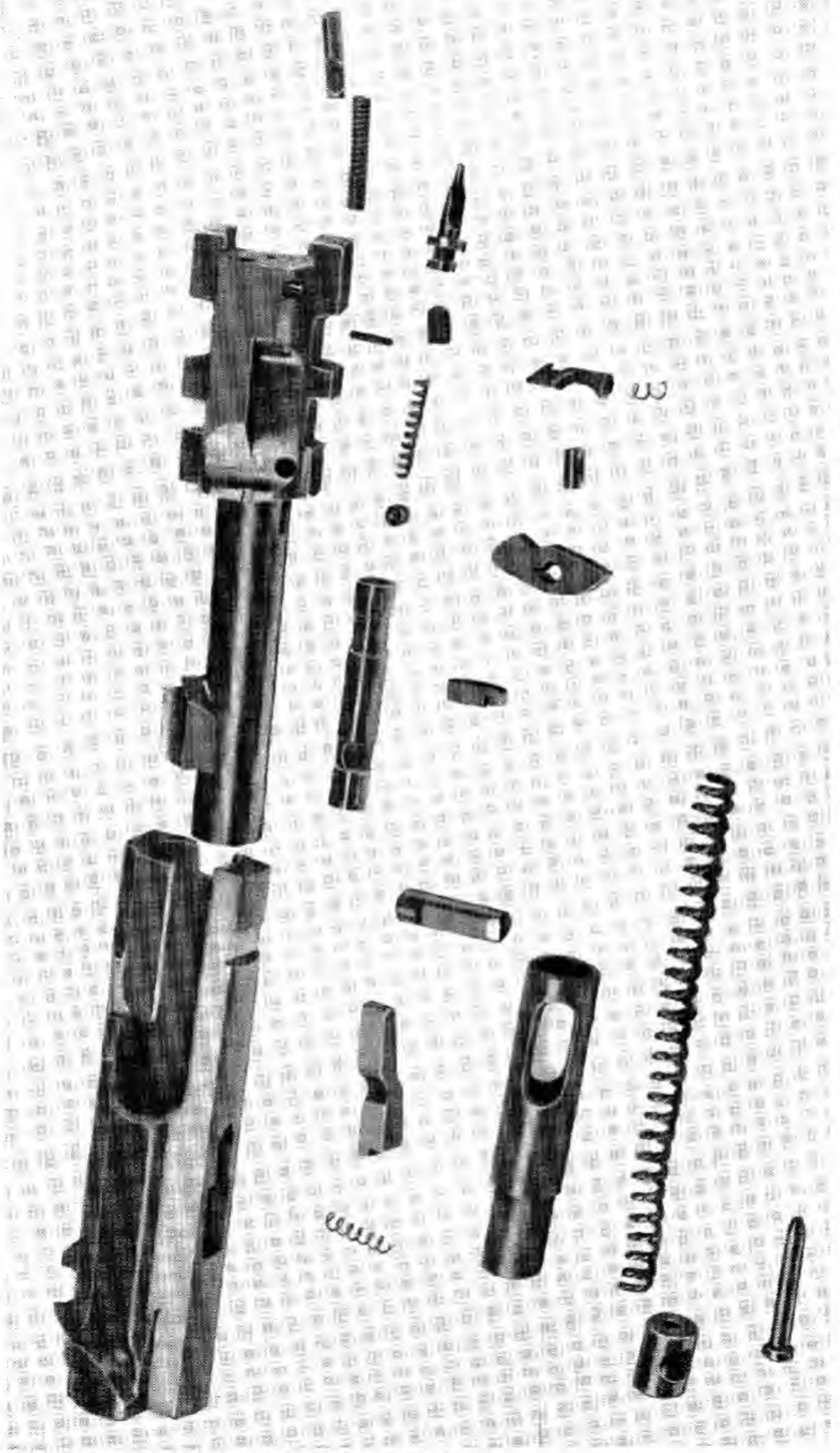

Figure 6–35. Synchronized version of 23-mm NS Gun. View of detail stripped bolt.

Figure 6-36. Synchronized version of 23-mm NS Gun. Barrel extension, viewed from the side.

Figure 6-37. Synchronized version of 23-mm NS Gun. Barrel extension, viewed from below.

Figure 6-38. Synchronized version of 23-mm NS Gun. View of barrel extension from side to show recess for lateral movement of ammunition.

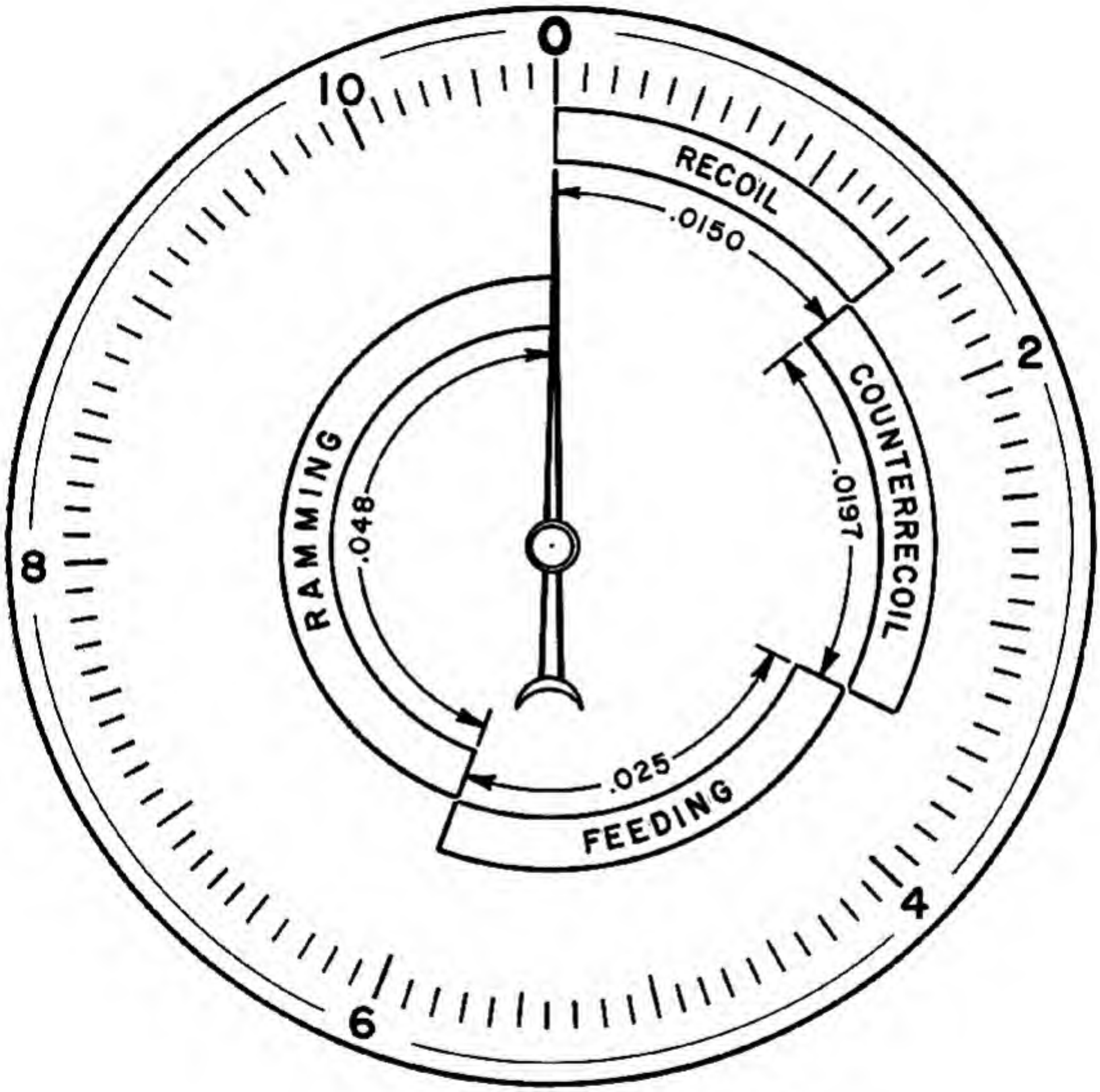

Figure 6–39. Time cycle for a 23-mm NS Gun.

Chapter 7

AUTOMATIC WEAPONS DERIVED FROM SKODA DESIGNS

Weapons Included in This Chapter

Designation	Use
30-mm FLAK Model A	Anti-Aircraft.
30-mm FLAK Model B	Anti-Aircraft.
50-mm PAK	Anti-Tank.
55-mm FLAK	Anti-Aircraft.
75-mm FLAK R4	Anti-Aircraft.
75-mm Recoilless	Aircraft.

History and Background

The world-famous Skoda Works was established in 1859 by the Count of Waldstein in Pilsen, then a city in Austria-Hungary. M. de Skoda became proprietor a few years later.

The factory engaged in various types of metal working and mechanical engineering, as well as the construction of war matériel.

The company's early record in the production of automatic weapons included the second successful automatic firing mechanism, which was patented in 1888 and appeared soon afterward. This weapon was preceded only by the Maxim gun. This 8-mm Skoda machine gun was invented by Grand Duke Karl Salvator and Colonel von Dormus, both of Austria, who sold their patent rights to the Skoda Works. After this venture, however, the company's interest turned to large-bore automatic weapons. In this field the company's products have been second to none throughout the years.

After the victorious Allies formed the independent country of Czechoslovakia at the close of World War I, the Skoda Works produced automatic weapons for not only the Czech Army but for other countries determined to encircle a defeated Germany. Very soon control of the Skoda plant was taken over by the French-owned Schneider Company, and in October 1919 the French Government appointed the French Military Mission to study the procedures developed by the Skoda plant and to impart to the management of the plant progressive French methods such as their advanced procedures in constructing experimental gun models.

The Mission was cordially received and collected extensive information about the ordnance designed in the Skoda plant as well as know-how valuable in the solution of various ordnance problems. Among those cooperating with the Mission were General Pelle who was made its head, his Chief of Staff, Colonel of Artillery Clausse, the organizer of the Czechslovakian Artillery; and Mr. Hasek, the manager of the Skoda Works, formerly an Austrian naval ordnance engineer.

Soon after the work of the Mission was completed, the Allies turned their attention to the need for creating a small-arms plant that would be on a par with the Skoda plant manufacturing facilities in the production of heavy armament. The location decided upon was Brunn, as a factory building was in existence there. The plant which was developed bears a Czechoslovakian name which has been shortened to the ZB Company. The following chapter is devoted to it.

Between World War I and World War II the Skoda Works continued to develop heavy armament. The weapons discussed in this chapter represent a portion of Skoda developments which have attracted the interest of many countries in the years since World War I, when Czechoslovakia became a nation. Access to these developments by various countries can only be suggested here. It is generally known, of course, that the facilities of the Skoda plant were used by the German forces after their occupation of the country in 1939.

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In the summer of 1945 when Allied ordnance teams visited the Skoda plant their study of interesting items was hampered by the lack of drawings and data which the company's officials accounted for as being destroyed by bombing. At that time the Russians were in control of Prague, and had access to copies of all drawings, designs, and technical data through the Skoda offices there.

In the period since World War II, the Skoda Works, like all Czech industrial enterprises employing more than 250 persons have been nationalized. After the Czech government obtained control, an attempt was made to begin moving munitions plants out of Bohemia and Moravia to the Eastern part of the country. Skoda development funds for the year 1947 were allotted to the restoration of the underground plant at Dubnica, which had been badly damaged in World War II. Two-thirds of the output of the eleven Skoda plants is earmarked for Russia.

Communist domination of Czechoslovakia in recent years is a matter of general information. It is known further that the weapons described in this chapter are in Soviet hands. Of particular interest in this field of automatic weapons are the contributions of certain individuals under Russian control to a development program which was under way in the Brunn plant at the time of German control. The fascination large-bore automatic armament holds for the Soviets indicates a trend which is tangent to Skoda developments under German supervision.

While the automatic cannon discussed here are somewhat officially referred to as anti-aircraft versions with a tremendous weight and low rate of fire, they are not to be dismissed without serious consideration of their basic features. They are all prototypes, and lightening them and speeding up the action for aircraft installation would be comparatively easy. One has only to remember that the Germans proved their famous 88 tank gun in the Spanish Civil War as an awkwardly designed anti-aircraft weapon that seemed so clumsy and inefficient that the Allied agents never called attention to its lethal potentialities. It was called a secret weapon at the beginning of World War II by Allied Ordnance men until it was revealed later by captured German documents that it had been in action for proving purposes all through the Spanish Civil War, but that its intended purpose was concealed by its use as an anti-aircraft gun.

Figure 7–1. Skoda 30-mm Automatic Gun, FLAK Model B, three-quarter front view.

Figure 7-2. Skoda 30-mm Automatic Gun, ГLAK Model B, right side view.

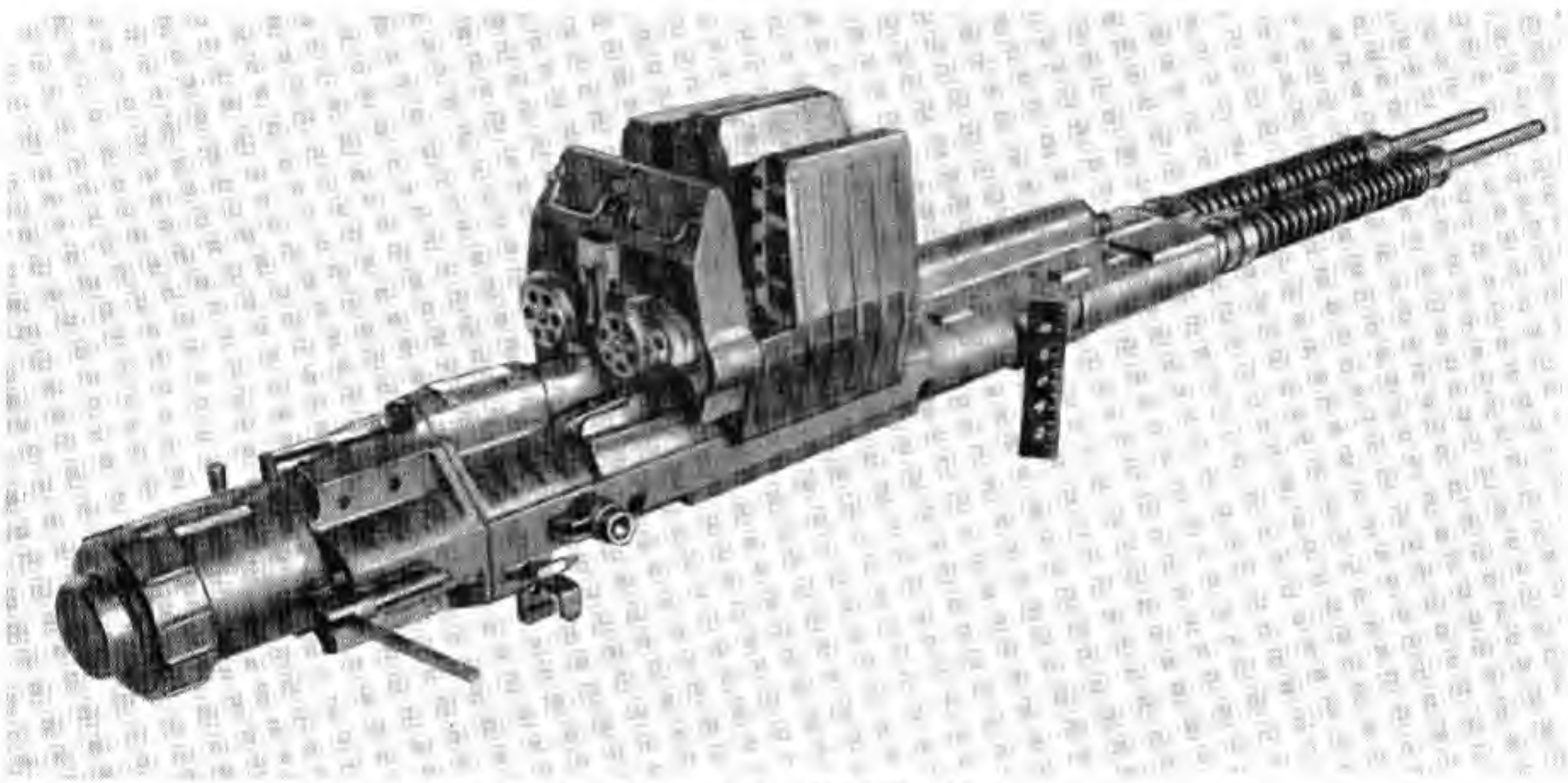

Figure 7-3. Skoda 30-mm Automatic Gun, FLAK Model B, three-quarter rear view.

SECTION 1. 30-MM FLAK MODEL A AND MODEL B

General Data on Model A and Model B

Caliber: 30-mm.
Rate of fire: 1,000 rounds/minute (approx.).
Muzzle velocity: 3,350 feet/second.
Gun length: 121.2 inches (approx.).
Gun weight: 1,380 pounds (overall weight of combined assembly).
System of operation: Blowback (retarded).
System of locking: Short recoil.
System of feeding: Magazine and metallic link belt.
Method of charging: Hydraulic on Model A (Manual on Model B).
Method of cooling: Air.
Barrel weight: 245 pounds.
Barrel length: 90.9 inches.
Barrel removal: Not quick change.
Bore:
  Direction of twist: Right hand.
  Form of twist: Standard constant.
Method of headspace: Factory established (not adjustable).
Location of feed opening: Top.
Location ejection opening: Bottom.

General Description of Model A and Model B

The design of this mechanism was begun in 1937 by the Skoda Works. It shows signs of having been inspired by both the Gast and the Becker, German guns of World War I which are described in Volume I of The Machine Gun.

This weapon is operated by short recoil and blow-back, is fed by twin loaders operated by bolt recoil, is fired by percussion firing mechanisms, and utilizes a hydro-spring recoil mechanism.

Unlike most twin guns, which fire independently, each gun is dependent upon the other, for the bolt of each gun is mounted integrally with the barrel of the opposite gun in order to increase the weight of the recoiling parts. Thus, if the left gun has fired, the bolt recoils by blow-back and carries with it the barrel of the right gun, and vice versa. Both guns must be in full recoil position in order to initiate firing, and each gun fires on the counter-recoil stroke of the other.

The guns are cocked simultaneously by hand operation of a crank, which mechanically retracts the firing mechanism.

Model A and Model B differ in the method of locking the gun in recoil position and releasing them at the proper time in the firing cycle. In the Model B this is done mechanically, while in the Model A it is done hydraulically. This difference is basic, causing many major and minor variations in the components and their operation. Comparison of the text for the two models points up these differences.

All illustrations show the Model B, which is the later model.

Detail Description of the Model A

A comparison of the detail descriptions of Model A and Model B points up an interesting difference in connection with the minimum burst for each model. Model A is fully automatic, being able to fire a minimum burst of two rounds by releasing the firing lever immediately after the bolt moves forward. The guns fire alternately until one of the loaders becomes empty or until the firing lever is released. Both guns are held in the full recoil position after the last round has been fired; thus the loaders may be recharged and firing resumed without cocking the guns, that is, locking them back in recoil position.

Recoiling Parts. The recoiling parts consist of two sets of similar parts, symmetrically arranged, each set being integral. One set consists of the left barrel, the left barrel recuperator spring, barrel extension, right bolt, and recoil piston rod. The other

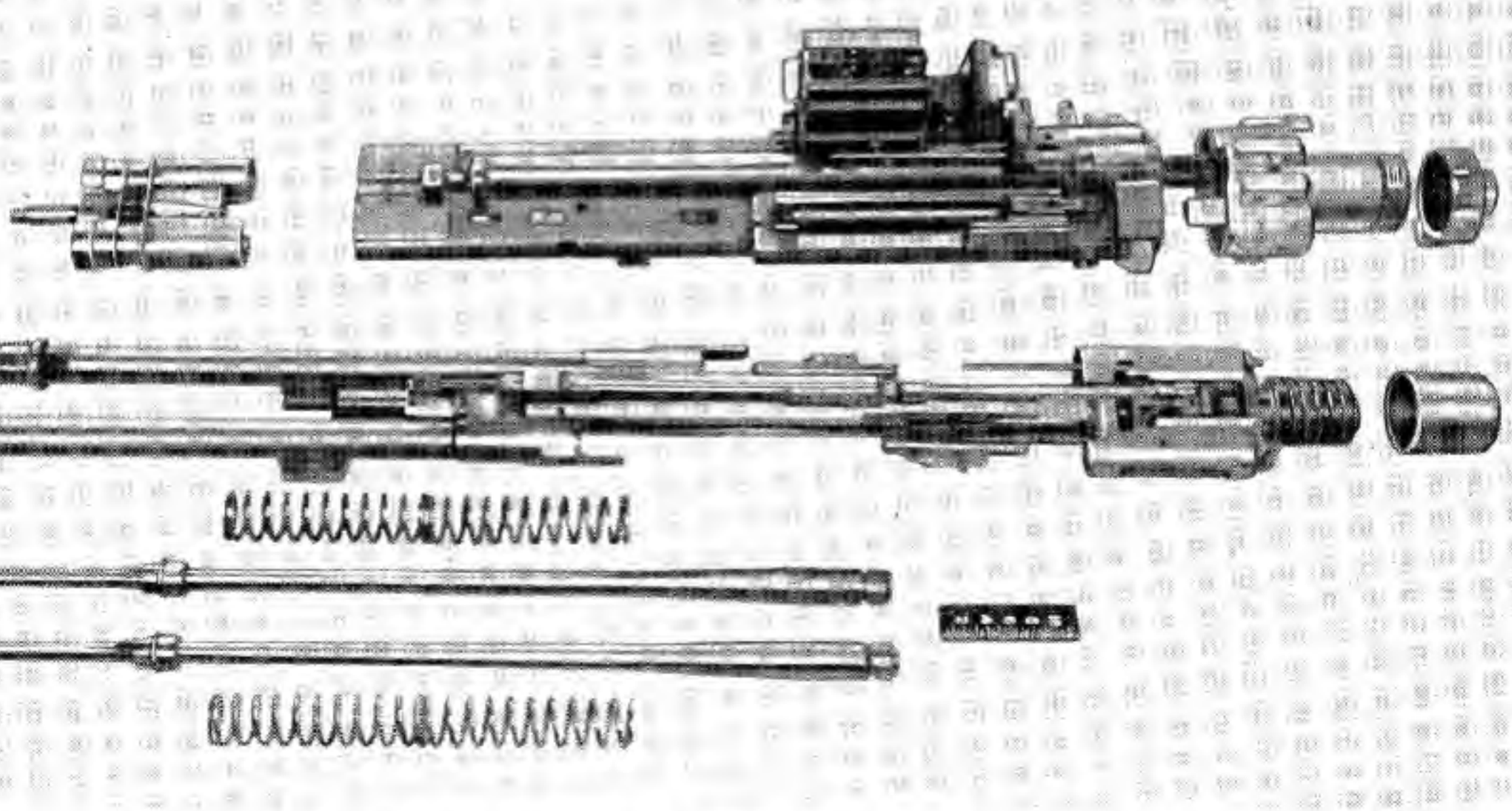

Figure 7-4. Skoda 30-mm Automatic Gun, FLAK Model B, stripped. Side view.

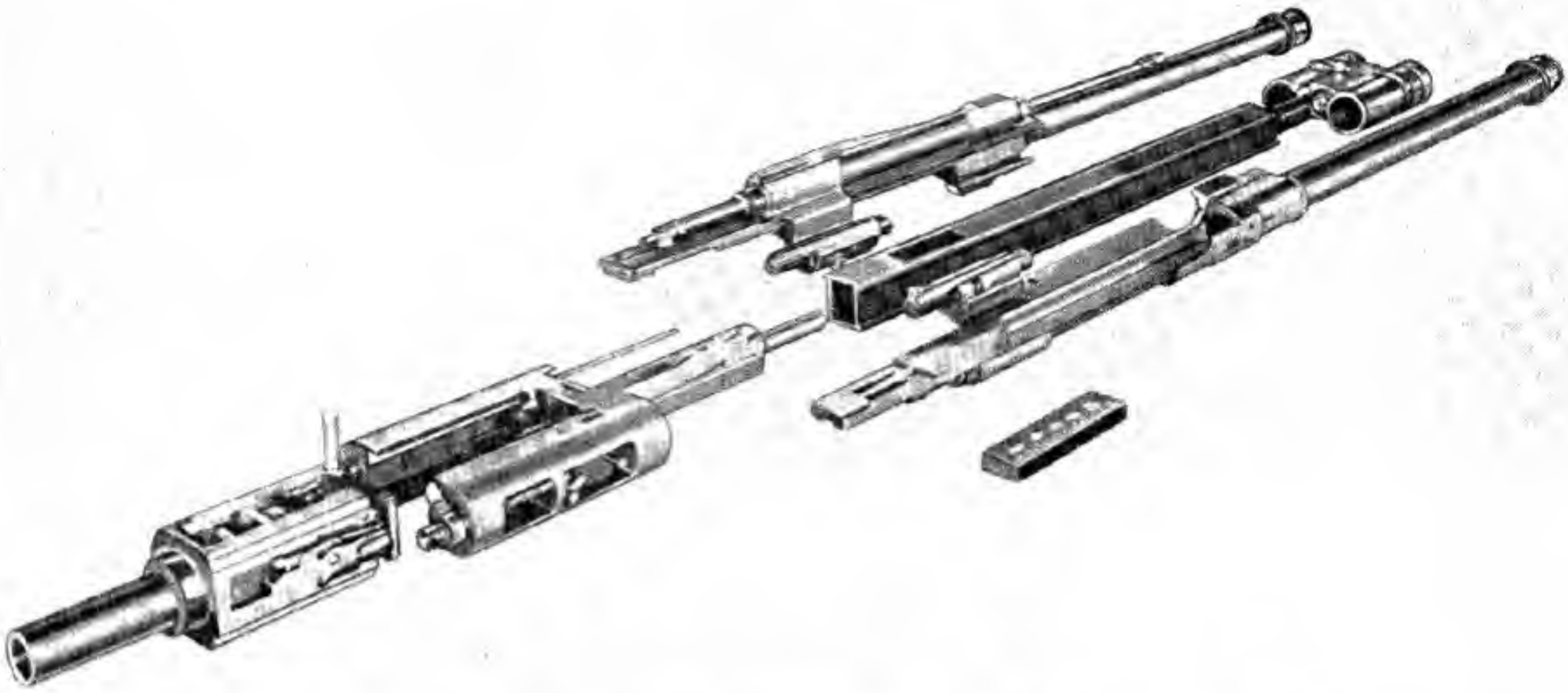

Figure 7–5. Operating parts of Skoda 30-mm FLAK Model B Automatic Gun.

set consists of the right barrel, the right barrel recuperator spring, barrel extension, left bolt, and recoil piston and rod.

Fixed Parts. The major fixed parts consist of the main housing; a recoil mechanism assembly which fits into the front end of the main housing and is secured by two wedges; a trigger assembly, sear assembly, and buffer assembly, which fit into the rear end of the main housing; a buffer housing, which fits into the rear end of the main housing and is secured by two wedges; a center guide on which the recoiling parts slide and which is held centrally between the recoil cylinder assembly and the trigger assembly; two ammunition loaders; two ejector and loader lock assemblies; charging mechanism with charging racks.

Barrels and Barrel Extensions. Each barrel has interrupted screw threads at the breech end, which mate with similar threads in the end of the barrel housing. Each barrel recoils through a sleeve in the front end of the recoil cylinder housing. A nut screws on the end of each barrel and permits adjustment of the initial compression of the recuperator springs.

Each barrel extension slides on a stationary central guide when the recoiling parts are in motion. The left barrel extension slides on the bottom and left side of the center guide, and the right barrel extension slides on the top and right side of the center guide. The surfaces interlock so that they cannot be disassembled except by sliding out the center guide.

A recoil piston rod is attached to a lug on each barrel extension and recoils with the extension. The top surface of the right barrel extension is inclined to form cam surfaces upon which cam followers ride to wind springs in the loader. On the inside of each barrel extension at the breech end is a sear plate which engages a sear in the sear assembly when the barrel is to be held in the full recoil position. Attached to each barrel extension just to the rear of the chamber is a firing cam which actuates the firing pin in the bolt as the bolt approaches the chamber.

Mounted on the right side of the left barrel extension and in line with the right barrel is the right bolt. Mounted on the left side of the right barrel extension and in line with the left barrel is the left bolt.

The recoil movement of each set of recoiling parts is limited by contact of the rear end of the barrel extension against the front end of the recoil buffer. Counter-recoil movement of each set of recoiling parts is limited by contact of the front end of the barrel extension against a surface in the recoil mechanism assembly.

Figure 7-6. Top-rear of breech end of Skoda 30-mm Automatic Gun FLAK Model B.

When both barrels are fully forward, there is a distance of approximately 18 inches between each bolt and its corresponding chamber. Thus, a round can be chambered only when both barrels are initially in the full recoil position. Only one gun can be loaded and fired at a time, for if both bolts were released, both barrels would go fully forward and neither gun could be loaded. Therefore, the barrel in which the round is being fired must be in the full recoil position at the time the bolt, which is moving forward under the pressure of the recuperator spring on the opposite barrel, chambers the round.

Main Housing. The main housing is a fabricated structure of symmetrical design. Near the rear end on each side is a large opening over which a loader is mounted and through which ammunition is fed to the gun and expended cases ejected. On the top of the main housing and at the rear of the loader openings are two ejector and loader latch assemblies which strike the base of the case as the bolt recoils and force it downward through the opening in the main housing.

In the top of the main housing opposite the ejector and loader latch assemblies are openings under which the loader winding mechanism operating cam in the right barrel extension moves during the recoil and counter-recoil of the right barrel extension. Through these openings extend cam followers which transmit motion to the spring winding mechanisms of the loaders.

On the top and bottom of the main housing are long raised sections in which the recoil piston rods recoil. The rear ends of these raised sections permit movement of racks and are used in cocking the guns. The rear end of housing also houses two pinion shafts at the top and bottom, and three idler gears which drive the cocking racks. The

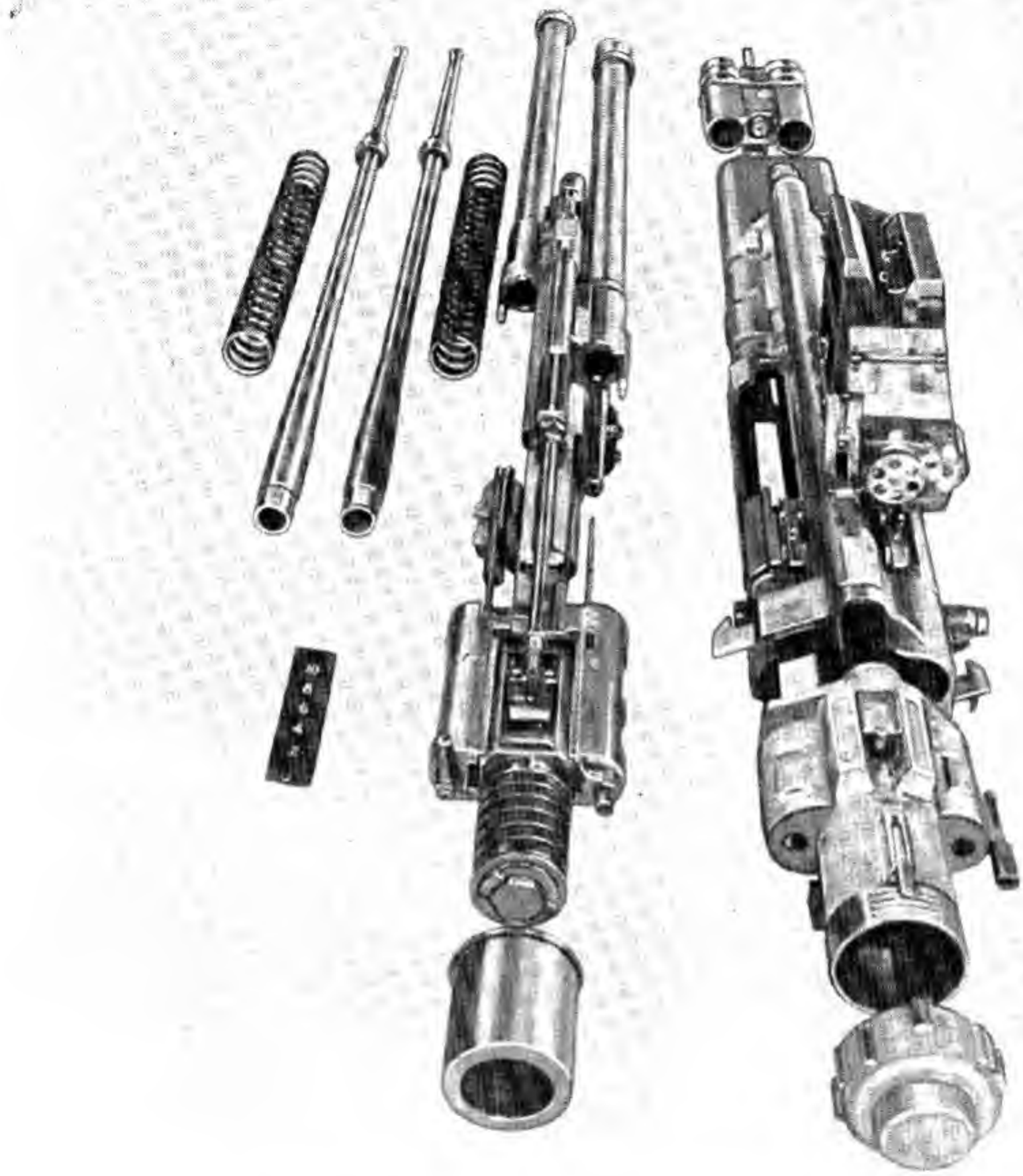

Figure 7-7. Skoda 30-mm Automatic Gun, FLAK Model B, stripped, rear view.

cocking mechanism bolts to the rear end of the housing on the left side.

In front of each loader is a spring-loaded plunger extending through the top of the housing. Pushing the plungers releases the barrel locks and permits the barrels to be turned and removed from the barrel extensions.

Recoil Buffer Housing. The recoil buffer housing fits into the rear end of the main housing and is held in place by two wedges. When in place, it holds the trigger assembly firmly against its seat in the rear end of the center guide. The recoil buffer housing also holds the buffer so that forward or rearward movement of the sear assembly within the trigger assembly compresses the buffer spring. Through the rear of the housing extends a handle

which actuates the sear lock. On the right side is a firing lever, firing lever safety lock, and a sear release lever.

Trigger and Sear Assemblies. The trigger assembly fits inside the hollow end of the center guide and is held in this position by the buffer housing. The sear assembly slides into the trigger assembly on guides and can move forward and backward against the pressure of the buffer spring which is mounted on the cylindrical extension at the rear of the sear assembly. The buffer housing is first assembled to the main housing, then the buffer components are assembled to the sear assembly and retained by two nuts. The cap on the rear end of the buffer housing holds the buffer in place within the housing. The spring can be compressed either by movement of the sear assembly rearward when the barrel extensions strike it upon recoil, or by movement of the sear assembly forward under the force transmitted to it through the bottom sear, which holds the left barrel extension in recoil position at the moment of firing.

The trigger and sear assemblies provide the means of holding the barrel extensions in the recoil position and the means of releasing them at the start of the firing cycle. After firing starts, locking of the barrel extensions in full recoil position and unlocking at the proper time in the firing cycle is accomplished hydraulically by the recoil system, as described in a later paragraph.

The top sear hinges upon a pin in the trigger assembly and bears against a spring-loaded plunger in the sear assembly. The finger of the top sear rests upon a flat in the sear trip shaft. The bottom sear hinges upon a pin in the sear assembly and bears against a spring-loaded plunger in the sear assembly. The finger of the bottom sear has a flat, which bears against a flat on the sear trip shaft, and a curved cam surface which bears against a dog. A spring-loaded plunger under the front end of the dog tends to keep the rear end depressed and bearing against the curved cam surface of the bottom sear finger.

On top of the dog is a spring-loaded slide which can be moved by a lever. When the slide is to the rear, it holds the rear end of the dog depressed. Thus, when the sear assembly is forced forward into the trigger assembly carrying with it the bottom sear, the finger of the bottom sear is cammed downward and the rear end of the sear, which engages the sear plate of the left barrel extension, moves up out of engagement with the sear plate and permits the barrel extension to move forward under the force exerted by the compressed barrel recuperator spring.

The top sear, which engages a sear plate in the right barrel extension, is moved out of engagement with the barrel extension when the sear trip shaft is rotated, allowing the barrel extension to move forward under the force exerted by the compressed recuperator spring of the right barrel. This is accomplished through the camming action between the sear finger and engaging flat on the trip shaft.

Further movement of the trip shaft will also cam the finger of the bottom sear downward to disengage the sear from the barrel extension. Further movement of the trip shaft is required for this because the end of the trip shaft which engages the bottom sear finger consists of two flats at an angle to each other. The second flat does not engage the finger until after the trip shaft is rotated sufficiently to trip the top sear. The trip shaft may be rotated by pulling the firing lever which, through linkage, turns the shaft which, in turn, pushes the plunger which is connected to the lever on the end of the sear trip shaft.

The firing lever can be removed just far enough to trip the top sear. However, one lever acts directly on another to rotate the trip shaft sufficiently to trip both sears. This lever is used, therefore, to release both barrel extensions and unload the barrel recuperator springs during a period of inactivity, and also serves as a safety to prevent accidental tripping of the sears by either the firing lever or sear lever.

The sear lock assembly fits into the round extension on the rear end of the sear assembly and is retained by a pin. Turning the handle rotates the lock shaft which moves forward under the camming action of the spiral grooves. When the lock shaft moves forward, its end engages mating recesses in the sear plungers (when the sears are in engagement with the barrel extension) so that the sears cannot be tripped. This is a safety feature to prevent accidental release of the barrel extensions on firing.

When the firing lever is operated to rotate the shaft, the link is pushed rearward, bringing the dog into engagement with the finger of the bottom sear.

Since the finger has not yet been depressed, the dog will bear against the side of the finger, and further movement of the firing lever will telescope the two plunger components within the connecting link. When the bottom sear finger is depressed by forward movement of the sear assembly into the trigger assembly, the dog will snap over the top surface of the bottom sear finger and hold it out of engagement with the barrel extension until the firing lever is released or until the link is moved out of engagement with the shaft by rotation of the lever.

Two levers are opposite a groove in the top left side of the trigger assembly, and one lever is opposite a groove in the top right side. When the gun is assembled, interlock rods extend rearward through these grooves from the rear ends of the ejector and loader latch assemblies. The interlock rods extending from the front ends of these assemblies are linked inside the assemblies to the rods extending from the rear in such a manner that when the front rods are pushed rearward, the rear rods are drawn forward. Each front rod contacts the lever in the loader, which is held depressed when ammunition is in the loader. Therefore, when ammunition is in the loader the rods extending rearward from the extractor and loader latch assemblies are held forward against springs in the assemblies.

When the last round leaves the left loader, a lever moves out and permits the read interlock rod to move to the rear and strike levers, disengaging the dog from the finger of the bottom sear and moving the slide forward out of engagement with the dog. The bottom sear then moves out to engage the left barrel extension, and since the dog is no longer held down against the cam surface of the sear finger by the slide, forward movement of the sear assembly cannot cam the sear out of engagement with the barrel extension.

When the last round leaves the right loader, a lever in the loader moves out and permits the rear interlock rod in the right ejector and loader latch assembly to move rearward and strike the lever, disengaging the link from the shaft and permitting the shaft to rotate. The top sear then springs out to engage the left barrel extension.

Assume that the loaders are full of ammunition and that both barrel extensions are in the full recoil position and engaged by the sears. Pulling the firing lever disengages the top sear and allows the right barrel extension and left bolt to move forward, strip a round from the left loader, and chamber it in the left barrel. As the round is chambered, the firing pin lever strikes the firing cam and fires the round. Blowback forces the left bolt, right barrel and extension rearward against the recoil buffer. The extension does not engage the top sear, as the sear is held out of engagement by the firing lever. The barrel and extension are held back, however, by hydraulic locking action in the recoil mechanism, as explained in a later paragraph.

At the time of firing, the force of friction between the moving projectile and the barrel forces the left barrel and barrel extension forward against the bottom sear which is assembled to the sear assembly. The sear assembly moves forward under this force, against the recoil buffer. This movement cams the bottom sear out of engagement with the left barrel extension and allows the left barrel, extension, and right bolt to move forward, strip a round from the right loader, and fire it in the right barrel. As the bottom sear is cammed out of engagement, the dog moves over the finger of the sear and holds it out of engagement, and the sear assembly and buffer resume their neutral position.

As the right bolt chambers and fires the round, the recoil piston of the left barrel causes the right barrel, extension, and recoil piston to be hydraulically unlocked. As the right bolt, left barrel, and extension recoil by blowback and strike the buffer and lock hydraulically in full recoil position, the left bolt, right barrel, and barrel extension move forward, and the bolt strips a second round from the left loader and fires it in the left barrel.

This cycle repeats until the firing lever is released or until one of the loaders becomes empty. If the firing lever is released, the top sear springs out to engage the right barrel extension, and the dog is pulled out of engagement with the bottom sear, which allows the bottom sear to engage the left barrel extension. Thus both barrels and extensions are held in full recoil position after firing ceases.

If the left loader becomes empty first, the left loader, interlock rod springs rearward from the left ejector and loader latch assembly, strikes levers, and allows the bottom sear to spring out to engage the left barrel extension as it recoils from firing the next to the last round from the right loader. When the last round from the left loader fires, the left bolt,

right barrel, and barrel extension recoil and are hydraulically locked in full recoil position, the top sear still being in the disengaged position if the firing lever is still held back. When the firing lever is released after firing ceases, the top sear springs out to engage the right barrel extension. Note that one round remains in the right loader after firing ceases.

Recoil System. The recoil system is a double hydro-spring system, consisting of a hydraulic recoil cylinder and piston rod, a replenisher, and a recuperator spring for each barrel. The hydraulic portion of the system is contained in the assembly. In addition to absorbing part of the recoil energy, the hydraulic system acts as a timing device, hydraulically locking each barrel and barrel extension in the full recoil position and unlocking them to permit them to go forward under the action of the recuperator spring at the proper time in the firing cycle.

The left cylinder contains a piston and a piston rod which is connected to the left barrel extension. The right cylinder contains a piston and a piston rod which is connected to the right barrel extension. The walls of the cylinders have throttling grooves of constant depth for the entire length, except approximately for 4 inches at the rear end where the bore is smooth.

The replenishers are smooth cylinders, each containing a spring-loaded piston. They serve to keep the system full of fluid and to permit expansion of the fluid. Two spring-loaded one-way valves are in the circuit connecting the left replenisher and the left recoil cylinder through lines. One valve has a stronger spring than the other valve. As the piston recoils into the smooth bore section of the cylinder, fluid is displaced to the front of the piston through lines and one-way valves. Flow of fluid into the replenisher is restricted by the small $\frac{3}{64}$-inch diameter orifice in the entrance to the replenisher. A one-way valve has a small $\frac{1}{32}$-inch diameter orifice through which fluid flows between the replenisher and recoil cylinder to compensate for leakage, expansion, and contraction of the recoil fluid. The one-way valve does not permit flow of fluid from the cylinder to the replenisher except through this orifice.

The piston of the left recoil cylinder is bypassed by the lines. This circuit is blocked by a spring-loaded valve, which is operated by a pressure differential in the lines leading from the valve to the front end of the right recoil cylinder. When the piston of the right recoil cylinder is moved forward, it passes the port of the line. Pressure ahead of the moving piston being greater than the pressure back of it causes the valve to open and connect the bypass lines. At this moment the piston of the left cylinder will normally be in the smooth bore section of the cylinder (full recoil position). Prior to opening of the bypass valve, the piston in the left cylinder cannot move forward under the force exerted by the barrel recuperator spring because fluid ahead of the piston cannot be displaced. As soon as the valve is open, however, fluid can be displaced from the front of the piston to the rear through the lines and valve. As soon as the piston enters the grooved section of the cylinder, fluid is displaced to the rear of the piston through the grooves. One valve closes when the forward movement of the piston in the right cylinder stops, as the pressures ahead of the piston is the same as the pressure back of it.

Assume that the left bolt, which is connected to the right barrel extension, is moving forward to chamber a round in the left barrel, which is in full recoil position. The right recoil piston rod, which is connected to the right barrel extension, is also moving forward, under the force exerted by the compressed recuperator spring on the right barrel. The left barrel, barrel extension, right bolt and left recoil piston are held in full recoil because the piston is in the smooth bore section of the cylinder and there is no path through which to displace the recoil fluid. As the piston in the right cylinder passes the port of the line, the differential pressure created in the lines opens the valve, allowing the piston in the left cylinder to move forward by displacing fluid to the rear through the valve. As the piston moves forward under the pressure exerted by the left barrel recuperator spring, the right bolt strips a round from the right loader and carries it forward. As the piston starts to move forward, the round being chambered in the left barrel fires. The left bolt, right barrel, and barrel extension are driven back by blowback, carrying the right recoil piston rearward into the smooth bore section of the cylinder. Fluid passes to the front of the piston through the throttling grooves until the piston reaches the smooth bore section of the cylinder. Fluid then passes to the front of the piston through lines and one-way

valves. The piston is held in this position until the piston passes the port of the line. The pressure differential created in these lines opens the valve, allowing piston to move forward by displacing fluid to the rear through the valve. This action repeats until one of the loaders becomes empty, or until the firing lever is released.

When the barrels are held in recoil position by engagement of the scars with the barrel extensions, the recoil pistons are probably just in front of the smooth bore section of the recoil cylinders. Thus hydraulic locking would not take place when the sears are released to allow the barrels to move forward for firing the first two rounds. Firing of the first two rounds and all subsequent rounds, however, causes the barrels to recoil past the position where the scars engage the barrel extensions. The recoil pistons then enter the smooth bore sections of the recoil cylinders and hydraulic locking takes place.

Since some clearance exists between the recoil cylinders and pistons, hydraulic locking cannot be maintained indefinitely. The piston will gradually move forward into the grooved section of the cylinder as oil is displaced to the rear of the piston through the clearance between the piston and cylinder.

Cocking Mechanism. The cocking mechanism provides means of retracting the barrels and barrel extensions until the extensions are engaged by the sears. It consists of racks, two pinion shafts which drive the racks, and a hand crank shaft and brake assembly which drives the pinion shafts simultaneously through three idler gears on the left side of the main housing. Each rack has a lug which engages a shoulder on the rear end of each barrel extension. After both barrel extensions are engaged by the sears, the racks are returned to their forward position by operating the hand crank shaft in reverse.

Loaders. The two loaders are similar in design to those for the Model B, differing only in the method of winding the loader springs. Each loader has a capacity of 9 rounds.

The rounds are fed downward by "star wheels" mounted on 8 shafts, all of which are driven by a common shaft which in turn is driven by a cross-shaft actuated by a spring in the housing. This spring is wound initially by hand by turning a knurled wheel, then both springs are wound simultaneously by action of cams in the top of the right barrel extension during recoil and counter-recoil of the extension. A cam follower rides in one of the cam grooves and moves up and down each time the right barrel extension recoils and counter-recoils. For each vertical movement of the cam follower the spring winding shaft is rotated one notch of the ratchet wheel, which is driven by the pawl in the follower shaft.

The lever is actuated by ammunition in the loader. When the lever is pressed into the end of the loader by the ammunition, it releases a ratchet which permits the star-wheel shafts to rotate under the power supplied by the loader spring. When the lever is released by the last round leaving the loader, it prevents unwinding of the loader spring. When the loader is in position, the interlock rod extending through the front end of the ejector and loader latch assemblies contacts the end of the lever. Thus when ammunition is in the loader, the lever pushes the interlock rod rearward, and when the last round leaves the loader, the lever permits the interlock rod to move forward.

Ejector and Loader Latch Assemblies. The ejector and loader latch assemblies are similar to those used on Model B. The assembly serves to latch the loader in position, eject expended cartridge cases, and house the loader interlock rods. Raising the lever on top of the assembly withdraws the latch and permits placing the loader in position.

The ejector, located under the end of the interlock rod, is spring-loaded to absorb the shock of striking the base of the empty case as the case is withdrawn to the rear by the bolt. The ejector rides in the groove in the top of the bolt as the bolt passes under it, and contacts the base of the case at the top, pivoting it downward over the extractor and through the opening in the main housing under the loader.

Extending through the front and read ends of the assembly are two interlock rods, one above the other. They are connected inside the assembly by a lever pivoted at its center. A spring maintains pressure on the rods to keep them in the extended position. If the front rod is pushed in, the read rod is withdrawn, and if the front rod is released, both rods are forced out by the spring.

Bolt. The bolts are similar to those used on the Model B. Each bolt consists of a bolt body, a spring-loaded extractor, two spring-loaded cartridge holding claws, a spring-loader firing pin, and a

firing pin actuating lever. There is no safety lock to be tripped to release the actuating lever, as in the Model B. The firing pin is normally held in the retracted position by its spring. It is moved forward to strike the primer by the actuating lever when the lever strikes the firing cam.

Cycle of Operation of the Model A

Preparation for Firing. Retract the barrels and barrel extensions by operating the retracting mechanism with a crank until both extensions are engaged by the sears. Then operate the retracting mechanism in reverse until the retracting racks are fully forward.

Turn the sear locking lever clockwise to lock the sears.

Turn the safety lever to the safe position.

Load a clip of rounds into each ammunition loader. Movement of the star-wheel shafts during loading is permitted by a clutch on each shaft. When the rounds are inserted in each loader, they press against levers and through the movement of the interlock rods in the ejector and loader latch assemblies, permit the levers to move forward and bring links in engagement with the lugs on the shaft. Movement of the firing lever which moves the shaft can then initiate firing.

Wind each loader spring by turning the knurled wheel.

Automatic Firing. Disengage the safety locks by turning the handle counterclockwise and the lever clockwise.

Pull back the firing lever to the limit of its travel, and hold it in this position until all rounds have been fired from one loader or until firing is to be suspended.

When the firing lever is pulled back, the bottom sear is disengaged, and the right barrel, barrel extension, and left bolt move forward under the force exerted by the right barrel recuperator spring. The bolt strips a round from the left loader and chambers it in the left barrel. Just before the round is completely chambered the bolt passes the firing cam, which engages the firing pin actuating lever in the bolt, causing the round to be fired. The left bolt, right barrel, barrel extension, and recoil piston rod all recoil under the force of the blowback, compressing the right barrel recuperator spring and throttling oil through the grooves in the recoil cylinder. The bolt extracts the expended cartridge case which is ejected when its base strikes the ejector near the end of recoil.

At the end of recoil the end of the barrel extension strikes the recoil buffer, and the recoil piston enters the smooth bore section of the cylinder, both of which absorb the remaining recoil energy. The barrel extension is not engaged by the top sear, as the sear is still held out of engagement by the firing lever, but the extension remains in full recoil position because recoil fluid cannot pass the recoil piston when it is in the smooth bore section of the cylinder. During recoil of the barrel extension the springs of both loaders are wound by the camming upward of followers by cam tracks in the top of the right barrel extension.

At the time the left bolt, right barrel, and extension are forced rearward by blowback force, the left barrel in which the round was fired and its extension are forced forward against the bottom sear by the force of friction between the moving projectile and the barrel. The sear assembly, under the action of this force, moves forward against the recoil buffer. This movement cams the bottom sear out of engagement with the left barrel extension and allows the left barrel, barrel extension, and right bolt to move forward under the force exerted by the recuperator spring, strip a round from the right loader, and chamber it in the right barrel. Just before the round is completely chambered the bolt passes the firing cam which engages the firing pin actuating lever, causing the round to be fired.

Also, just before the round is completely chambered, the left barrel recoil piston passes the control port of the right barrel recoil cylinder by-pass valve, causing the valve to open and allowing the right barrel, barrel extension, and left bolt to move forward under the force of the recuperator spring.

The right bolt, left barrel, barrel extension, and recoil piston all recoil under the force of blowback, compressing the recuperator spring and throttling fluid through the grooves in the recoil cylinder. The bolt extracts the expended case which is ejected when its base strikes the ejector near the end of recoil.

At the end of recoil the end of the barrel extension strikes the recoil buffer, and the recoil piston enters the smooth bore section of the cylinder, both of which absorb the remaining recoil energy. The

barrel extension is not engaged by the bottom sear, as the sear is held out of engagement by the dog. The extension does remain in full recoil position, however, because fluid cannot pass the recoil piston when it is in the smooth bore section of the cylinder.

While the left barrel and right bolt are recoiling as described in the preceding paragraph, the right barrel and left bolt move forward, strip a second round from the left loader and fire it in the left barrel. As the round is chambered, the left barrel and barrel extension are hydraulically unlocked by the opening of the left barrel recoil cylinder bypass valve, and allowed to move forward as the right barrel is recoiling.

The guns continue to fire alternately as just described as long as the firing lever is held in the firing position or until one loader becomes empty. If the firing lever is released, both sears spring out to engage the barrel extensions and hold them in the full recoil position. If one of the loaders becomes empty (the left loader becomes empty first if both are initially loaded with the same number of rounds) the loader interlock rod in the corresponding ejector and loader latch assembly strikes the corresponding interlock lever in the trigger assembly releasing the sear which engages the barrel extension of the barrel in which the last round is fired. The bolt, barrel, and barrel extension which recoil upon firing the last round are locked back hydraulically when the recoil piston enters the smooth bore section of the recoil cylinder. When firing ceases, the firing lever would normally be released, allowing the other sear to spring out in position to engage the barrel extension hydraulically locked in full recoil.

If no further firing is to be done, both barrel recuperator springs may be released by actuating the sear trip lever which disengages both sears and allows both barrels and their barrel extensions to move forward.

Detail Description of the Model B

A comparison of the detail descriptions of Model A and Model B points up an interesting difference in connection with the minimum burst for each model. Model B is fully automatic, but single shots can be fired by manipulation of the lever that serves as a disconnector. When individual rounds are fired, only the left gun can be fired, there being no means for firing the right gun singly. Since manually cocking the guns was not possible, it is assumed that some other means was provided in the design of the weapon.

Recoiling Parts. The recoiling parts consist of two sets of similar parts, symmetrically arranged, each set being integral. One set consists of the left barrel, left barrel recuperator springs, left barrel housing, and barrel extension, right bolt, recoil cylinder, and the loader winding mechanism operating cam. The other set consists of the right barrel, right barrel recuperator springs, right barrel housing, and barrel extension, left bolt, and a recoil cylinder.

Fixed Parts. The major fixed parts consist of the main housing; a counter-recoil buffer assembly which fits into the front end of the main housing and is retained by screws; a trigger assembly, sear assembly, and recoil buffer assembly which fit into the rear end of the main housing; a buffer housing which fits into the rear end of the main housing and is secured by two wedges; a center guide on which the recoiling parts slide and which is held centrally between the counter-recoil buffer and the trigger assembly; two recoil pistons and rods mounted in the two recoil cylinders; two ammunition loaders; and two ejector and loader lock assemblies.

Barrels and Barrel Extensions. Each barrel has interrupted screw threads at the breech end, which mate with similar threads in the breech end of the barrel housing. About ⅓ the length of the barrel from its muzzle end, there is a collar with spring-loaded detent locks which fit into the muzzle end of the barrel housing when the barrel is installed and prevent the barrel from turning. Screwed to the end of the barrel housing is a sleeve which bears against the end of the recoil spring when the spring is compressed during recoil.

Extending to the rear and on one side of each barrel housing is an extension which slides on a stationary central guide when the recoiling parts are in motion. The left barrel extension slides on the top and left side of the center guide, and the right barrel extension slides on the bottom and right side of the center guide. The surfaces interlock so that they cannot be disassembled except by sliding out the center guide. A recoil cylinder is mounted on the outside of each barrel extension and recoils

with the extension. On top of the recoil cylinder of the left barrel extension is a cam which recoils also and operates both loaders through the loader winding mechanism. On the inside of each barrel extension at the breech end is a sear plate which engages a sear in the sear assembly when the barrel is to be held in the full recoil position, two recesses to permit movement of the sear locks, and an abutment which actuates a slide in the trigger assembly. Just opposite the chamber on the outside of each barrel extension is a cam which actuates the firing pin in the bolt as the bolt approaches the chamber.

The right bolt is mounted on the right side of the left barrel extension and in line with the right barrel. The left bolt is mounted on the left side of the right barrel extension and in line with the left barrel.

The recoil movement of each set of recoiling parts is limited by contact of the rear end of the barrel extension with the laminated plates of the sear assembly located behind the sear. The recoil buffer absorbs the shock of this impact. Forward movement of each set of recoiling parts is limited by contact of the shoulder near the breech end of the barrel housing with the movable cylinders of the front buffer. When both barrels are fully forward, that is, when the shoulders on the barrel housings are in contact with the front buffer, there is a distance of approximately 18 inches between each bolt and its corresponding chamber. Thus, a round cannot be chambered by the bolt in this position. A round can be stripped from the loader and chambered only when both barrels are initially in the full recoil position.

Only one gun can be loaded and fired at a time, for if both bolts were released, both barrels would go fully forward and neither gun could be loaded. Therefore, the gun being fired must be held in the full recoil position while the other gun is released and allowed to move forward under the pressure of the recuperator springs on the barrel housing. The gun which is fired must be held in full recoil position until the other gun is blown back to full recoil position, where it is held. The gun just fired is then released, and allowed to move forward to charge and fire the other gun.

Main Housing. The main housing is a fabricated structure of symmetrical design. Near the rear end on each side is a large opening over which a loader is mounted and through which ammunition is fed to the gun and expended cases ejected. On the top of the main housing and at the rear of the loader openings, there are two ejector and loader latch assemblies which strike the base of the case as the bolt recoils, and forces the case downward through the opening in the main housing.

Located between the front ends of the loader openings in the top of the main housing is an opening under which the loader winding mechanism operating cam and recoil cylinder move during recoil and counterrecoil of the left barrel extension. The loader winding mechanism is mounted over this opening. A roller in the loader winding mechanism follows the cam through this opening and transmits power to both loaders simultaneously.

On the top and bottom of the main housing are long raised sections in which the recoil cylinders recoil. The recoil piston rods are attached to the main housing at the front ends of these raised sections by means of yokes and keys.

Recoil Buffer Housing. The recoil buffer housing fits into the rear end of the main housing and is held in place by two wedges. When in place, it holds the trigger assembly firmly against its seat in the rear end of the main assembly. It also holds the buffer so that forward or rearward movement of the sear assembly within the trigger assembly compresses the buffer spring. Through the rear of the housing on the left, extends a handle which releases the left barrel extension, and on the right, the firing plunger and lock. On the right side is a bracket for mounting a firing linkage mounted on this bracket. This lever is not an original component, but was added to improve the functioning of the mechanism. In the top and bottom and on each side, are four sets of rollers, two in each set, accessible by removing a slide cover. The top rollers bear against the beveled sides of the left barrel extension as it recoils over the sear, to make it engage the sear. The bottom rollers perform the same function in relation to the right barrel extension. Between the two top sets of rollers is a cover which provides access to the orifice adjusting screw for the left barrel extension recoil cylinder. A similar cover is on the bottom for the orifice adjusting screw of the right barrel extension recoil cylinder.

Trigger and Sear Assemblies. The long rectangular extension at the front of the trigger

assembly fits inside the hollow square section of the center guide and is held in this position by the buffer housing. The sear assembly slides into the trigger assembly on guides and can move forward and backward against the pressure of the buffer spring, which is mounted on the cylindrical extension at the rear of the sear assembly. The buffer housing is first assembled to the main housing, then the buffer spring within its cup-shaped sleeve is assembled to the sear assembly and retained by a large screw. The cap on the rear end of the buffer housing holds the buffer in place within the housing.

The sear and trigger assemblies are separated about 2 inches when the buffer spring is not being compressed. The spring can be compressed either by movement of the sear assembly rearward when the barrel extensions strike it upon recoil or by movement of the sear assembly rearward when the barrel extensions strike it upon recoil or by movement of the sear assembly forward under the force transmitted to it through the sear which holds the barrel (from which the round is being fired) in recoil position at the moment of firing.

The sear assembly provides the means of holding the barrel extensions in the recoil position and the means of releasing them at the proper moment in the firing cycle. On its top and bottom are two identical sets of parts. They consist of the sear, the sear spring and plunger, a pin upon which the sear pivots, the left sear lock, the right sear lock, a pin upon which the sear locks pivot, and two spring-loaded plungers which bear against lugs extending from the top of the sear locks to keep them engaged.

The upper left and lower right sear locks have rollers at their tips on the inside. These rollers are contacted by operating slides in the trigger assembly and permit automatic tripping of the sears. The barrel extension is held in the full recoil position by the sear in contact with the sear plate on the barrel extension. As the sear plate recoils over the sear assembly, it first contacts the levers of the sear locks and depresses them against their springs. This unlocks the sear so that it can be depressed. As the barrel extension recoils farther, it contacts the top of the sear and depresses it. The width of the sear plate is such that it depresses the sear while the sear locks are still depressed and disengaged from the sear.

As the sear plate recoils past the sear, the sear moves out under pressure of its spring-loaded plunger to engage the sear plate, and, at the same time, the sear locks move out under pressure of their plungers and lock the sear in place. The levers on the sear locks, upon moving out, enter the narrow slots in the barrel extension ahead of the sear plate. The barrel extension is then held in the recoil position until both sear locks are tripped. The pressure exerted by the compressed recuperator springs on the barrel housing is sufficient to depress the sear against the plunger, when the sear locks are depressed, and force the barrel extension forward over the sear. This action is identical for both barrel extensions.

The levers on each side of the sear assembly are for manually disengaging the sear locks from the sears. One lever trips the upper right sear lock, while another lever trips the lower right sear lock. These levers, along with another lever, turn upon a common shaft. The now fully depressing lever causes the rear end of the trip pawl to contact the edge of the sear housing and disengage it from its mating lever, which is operating the lower right sear lock. This permits another lever to spring up, out of engagement with the lower right sear lock, and allows the sear lock to engage the sear again.

If the lever is held down, the lower left and upper right sear locks are held out of engagement with the sears. The other two sear locks are the ones with rollers on their ends, and are automatically operated by the unlocking slides which extend through the back of the trigger housing into the opening in the front of the sear housing. The upper left sear lock, which has a roller on its end, is unaffected by movement of the lever. It can be tripped manually and is directly over the flat end of the lever when the sear assembly is assembled to the trigger assembly. The operating handle is turned, the left barrel extension, which is held back by the top sear, is free to move forward.

The guides in the trigger assembly engage the follower on the trigger lever, and when the sear assembly is assembled to the trigger assembly. These guides are free to move vertically on pins when interlock rods are in their rearmost position, for, in this position, a flat section on each rod is opposite a depression in the shank of each guide and

permits the guide to clear the rod. When both rods are forward, a round section of each rod engages the depression in the shank of each guide and locks the guide in the up position.

The firing plunger, when moved forward, forces the guide downward by means of the linkage, provided both interlock rods are rearward; unless the rod is held back, the guide which engages the follower on the lever will not be free to move. Pulling back the firing lever also pushes the firing plunger forward and causes the lever to be depressed. The accompanying action is explained in the three preceding paragraphs.

The interlock rods that extend through the ejector and loader latch assemblies, and the rectangular hole in the end of each rod engage the lever on the loader, which is connected by shafts and links to their respective levers. When ammunition is in the loader and the lever is pressed outward and the interlock rod is moved, the firing plunger cannot be moved forward unless ammunition is in the loaders, and the sears cannot be tripped to allow the bolts to move forward upon empty chambers except by moving both interlock rods back manually.

On each side of the rectangular extension of the trigger assembly is a slide which fits into a diagonal groove. The rear end of the slide is wedge shaped, the forward end carries a spring-loaded lever, and the central part contains a spring-loaded plunger assembly which bears against a shoulder in the trigger housing.

The left slide slopes upward to the rear, and the right slide slopes downward to the rear. The wedge-shaped ends of both slides extend through the back of the trigger housing and contact the rollers on the sear locks. The right slide actuates the lower right sear lock, and the left slide actuates the upper left sear lock; the spring-loaded lever in the end of the right slide extends through an opening in the top of the center guide. The corresponding piece on the left guide extends through the bottom side of the center guide.

As the right bolt and left barrel extension recoil by blowback after firing a round in the right chamber, the shoulder on the left barrel extension corresponding to the plate on the right barrel extension contacts the lever and pushes the right slide downward to the rear until the lever slides off the shoulder and under the barrel extension.

NOTE. During firing, the end of the extension never slides off the lever, so that the lever is always struck in counter-recoil by the slide-operating plate, and never by the sear plate.

The lever is then depressed, and permits the slide to move forward under pressure of the return spring which was compressed during the rearward movement of the slide. As the slide moves to the rear, its wedge-shaped rear end contacts the roller on the end of the lower right sear lock in the sear assembly and disengages it from the bottom sear, allowing the right barrel extension to move forward provided the firing lever is held back, which keeps the lower left and upper right sear locks disengaged.

In the meantime, the left barrel extension has been locked in full recoil position by the top sear. As the right barrel extension and barrel move forward under pressure of the recuperator spring on the right barrel housing, the left bolt, which is mounted integrally to the right barrel extension, strips a round from the left loader, chambers it in the left barrel, and fires. As the left bolt and right barrel extension recoil, compressing the right recuperator spring, the plate on the barrel extension strikes the lever on the left slide which extends through the bottom of the center guide, and pushes the slide upward to the rear. As the slide moves to the rear, the wedge-shaped rear end contacts the roller on the upper left sear lock, disengages it from the top sear, and allows the left barrel extension and right bolt to move forward.

In the meantime, the right barrel extension has been locked in the full recoil position by the bottom sear. As the left barrel and barrel extension move forward under pressure of the recuperator spring on the left barrel housing, the right bolt strips a round from the right loader, chambers it in the right barrel, and again fires. This cycle repeats as long as the firing lever is held back and until all ammunition is fired from both loaders.

Movement of the left loader interlock rod actuates the slide through a connecting lever, which in turn actuates the lock, the top of which slides in a slot of the slide. The lock extends through the front end of the trigger housing and underneath the right unlocking slide, where it can contact a hook extending downward from the lever in the slide. When the rod is pushed back, as is the case when ammunition is in the loader, the slide moves forward and with-

draws the lock to the left, disengaging it from the lever. The lever can then spring up again, after being depressed, as occurs on movement of the slide due to recoil of the left barrel extension. However, if the rod is moved forward, as is the case when the last round leaves the left loader, the slide moves to the rear and moves the lock to the right and in engagement with the lever, so that if the lever is depressed, it remains depressed. Thus, when the last round is stripped from the left magazine by the left bolt, which is integral with the right barrel extension, the interlock rod moves forward and the action just described occurs.

The right loader interlock rod acts similarly in locking the lever in the end of the left slide when the last round leaves the right loader.

After firing the last round from the left loader, the right barrel extension recoils, trips the upper left sear lock, and is locked in the full recoil position by the bottom sear. The left barrel extension moves forward over the slide and the lever to fire the last round from the right loader. Since the interlock rod is now forward and the lock is in engagement with the lever, the lever remains depressed. The left barrel extension, upon recoiling, then cannot move the slide to the rear and unlock the right barrel extension, which if unlocked, would carry the left bolt into an empty chamber. Both barrel extensions are then locked to the rear, and firing may be resumed after ammunition is placed in the loaders.

This is the action which normally takes place when firing automatically, for the right barrel extension is always released first when the firing lever is pulled, so that the first round fired is always from the left loader. The left loader will then become empty first, and the action just described will occur.

However, if fewer rounds are placed in the right loader, then the right loader will become empty first. The right interlock rod will then move forward, after the left barrel extension and right bolt have moved forward to fire the last round from the right loader. The lever in the end of the left unlocking slide then becomes locked down after the right barrel extension and left bolt move forward to fire the next round, and the right barrel extension, upon recoil, cannot move the left slide to the rear to trip the upper left sear lock and allow the left barrel extension and right bolt to move forward upon an empty chamber.

Firing of individual rounds might possibly be accomplished by pulling the firing lever (moving the firing plunger forward) and releasing it after the right barrel extension is released. This could be done for each round fired until all rounds have been fired from the left loader. Note that pulling the firing lever trips all sear locks except the upper left, and releases the right barrel extension. Releasing the firing lever permits the sear locks to re-engage the sears so that the left barrel extension will not be released automatically by recoil of the right barrel extension. Pulling the firing lever after the last round has been fired from the left loader, will allow the left bolt to move forward into an empty chamber. Thus, the firing of individual rounds from the right loader apparently cannot be performed.

Loaders and Winding Mechanism. The two loaders are identical in design, except that one is left-hand and the other right-hand. Each loader has a capacity of nine rounds. The rounds are fed downward by "star wheels" mounted on eight shafts, all of which are driven by a shaft through a common drive shaft. The shaft receives its power from a spring in the housing which is wound when the ratchet wheel is turned. The ratchet wheels on both loaders are turned one notch each time the left barrel recoils, by vertical movement of the ratchet wheel actuating pawls in the loader winding mechanism. The pawls are moved vertically by an arm whose roller rides on the cam.

The lever in the loader engages the loader interlock rod. Ammunition in the loader presses the lever outward and holds the lever rearward through the shaft. The shaft is also connected through linkages to the lever, which operates a pawl in engagement with a pawl wheel on the drive shaft. With ammunition in the loader, the lever is disengaged from the pawl wheel on the loader drive shaft, and the shaft is free to rotate. When the loader becomes empty, the lever engages the pawl wheel on the drive shaft, keeps it from rotating, and prevents the loader spring from unwinding.

Ejector and Loader Latch Assembly. The ejector and loader latch assemblies serve to latch the loader in position, as well as to eject the case. The long lever on top withdraws the latch and permits placing the loader in position. When the loader is in position, the latch engages a latch plate on the loader and holds it in position.

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The interlock rod extends through the round shank of the ejector and latch assembly. The lever engages a notch in the interlock rod and keeps the rod in its rearward position until the lever on the loader engages a hole in the end of the rod, when the loader is being placed in position. When the loader is in position, the lever is depressed and disengaged from the interlock rod, and allows the interlock rod to move forward.

The ejector is spring-loaded to absorb the shock of striking the case. The bolt has a groove in its top through which the ejector slides during recoil of the bolt. The nose of the ejector strikes the top edge of the base of the cartridge case and pivots it downward through the opening in the main housing under the loader.

Bolt. Each bolt consists of a housing, a spring-loaded extractor, two spring-loaded cartridge holding claws, a firing pin, firing pin spring, firing pin actuating lever, a pivot pin, and a safety lock. The firing pin is normally held in a retracted position by its spring. It is moved forward by the firing pin actuating lever, which engages the slot in the firing pin and pivots upon the pin. The firing pin actuating lever cannot be rotated upon its pivot pin until the safety lock is depressed sufficiently to disengage its lug from the firing pin actuating lever.

The left bolt is attached to the right barrel extension by means of a key. In this position, it is in line with the chamber of the left barrel. When the right barrel extension is disengaged from its sear, the left bolt moves forward under the left loader. The top edge of the bolt contacts the base of the cartrdige, strips it from the loader, and forces it into the chamber. As the cartridge enters the chamber, its base slides downward against the face of the bolt, and the rim engages the holding claws on each side of the bolt and the extractor on the lower side of the bolt. Just before the cartridge is fully chambered, the beveled surface of the safety lock contacts the firing cam on the side of the barrel housing. After the safety lock is fully depressed, the firing pin actuating lever strikes the firing cam and moves the firing pin forward to fire the round. When the bolt recoils, the firing pin is retracted by its spring, and the extractor, which is in engagement with the rim of the cartridge case, extracts the expended case.

Recoil System. Each barrel extension has assembled to it a recoil cylinder which recoils with the barrel extension over a fixed recoil piston and rod.

The piston rod and the piston are assembled in the recoil cylinder by means of a packing gland at each end of the cylinder. The cylinder is fixed rigidly to the barrel extension by a pin. The piston rod is hollow throughout its length. In front of the piston is a large orifice through the rod, and back of the piston is a long narrow orifice through the rod. An orifice control rod fits inside the rear half of the piston rod and is held in place by a fitting. Screwing the control rod through its retainer controls the size of the long narrow orifice behind the piston. In the front end of the piston rod there is also a fitting for attaching it rigidly to the main housing. The piston is fixed rigidly on the recoil rod and contains no orifices or valves. The oil is throttled through the orifices in the recoil rod during both recoil and counter-recoil.

Front Buffer. The front buffer consist of a fixed housing which fits into the front end of the main housing and through which a movable portion slides. A stationary piston rod, on which is mounted the piston, is attached to the housing and extends through the buffer cylinder. A packing nut screws into the packing gland. The return spring housing screws over the packing gland, which screws into the packing nut, which screws into the rear face of the movable portion.

A sleeve inside the return spring slides over the piston rod and is limited in travel by a shoulder on the piston rod. The piston contains orifices which are covered on the rear face of the piston by a spring-loaded plate which contains orifices smaller than those in the piston. During forward movement by the buffer, the plate is held against the piston. During rearward movement of the buffer, the plate is forced back against its spring, uncovering the piston orifices.

The movable portion consists of two cylinders through which the barrel housings and barrel extensions slide in recoil and counter-recoil. A shoulder at the rear end of each barrel housing strikes the rear end of the corresponding cylinder of the front buffer when both barrel extensions are released and allowed to move forward. The front ends of these cylinders bear against the ends of the barrel return springs. When the barrel housings strike the buffer, the movable portion of the buffer is forced downward over the recoil piston and

against the pressure of the return spring. Throttling of the oil in the buffer cylinder through the orifices in the spring-loaded plate retards the forward movement of the barrel extensions.

The buffer does not function during firing, but only when both barrel extensions are released to unload the recuperator springs for a period of inactivity.

Cycle of Operation of the Model B

Preparation for Firing. Load a clip of rounds into each ammunition loader. Movement of the star-wheel shafts during loading is accomplished by means of a clutch on each shaft. When the rounds are inserted in the loader, they press against the lever and move the interlock rods rearward through the action of the lever in the loaders. Movement of the interlock rods to the rear permit vertical movement of two guides when the firing lever is actuated.

Wind up each loader spring by turning the knurled wheel opposite the ratchet wheel.

Retract both barrel extensions until they are engaged by their respective sears.

Automatic Firing. Set the lever to the firing position. This permits the firing plunger to move forward when the firing lever is pulled back.

Pull back the firing lever to the limit of its travel and hold it in this position until all rounds have been fired from the loaders or until firing is to be suspended.

When the firing lever is pulled back, the sear locks are disengaged from the bottom sear, and the right barrel, barrel extension, and left bolt move forward under the force exerted by the right barrel recuperator spring. The bolt strips a round from the left loader and chambers it in the left barrel. Just before the round is completely chambered, the bolt passes the firing cam which engages first the safety lock and then the firing pin actuating lever in the bolt, causing the round to be fired. The left bolt, right barrel, barrel extension, and recoil cylinder recoil by blowback, compressing the right barrel recuperator spring and forcing oil through the orifices in the recoil piston rod. The bolt extracts the expended cartridge case, which is ejected when the base of the case strikes the ejector near the end of recoil. At the limit of its recoil, the barrel extension strikes the recoil buffer, which absorbs the remaining energy of recoil, and engages the bottom sear which holds the barrel extension in the full recoil position.

During the initial recoil movement of the right barrel extension, the plate on the extension strikes the lever on the left sear latch trip slide and moves the slide upward to the rear. The rear end of the slide contacts the roller on the upper left sear lock, disengages it from the top sear, and allows the left barrel extension and right bolt to move forward under the force exerted by the left barrel recuperator spring.

As the right bolt moves forward, it strips a round from the right loader and chambers it in the right barrel. The loader-operating cam on the top of the recoil cylinder moves forward with the barrel extension, forces the loader winding mechanism follower upward, and causes the winding ratchet pawls to move downward, to engage a notch in each loader spring winding ratchet wheel, and to wind both loader springs. Just before the round is completely chambered, the bolt passes the firing cam on the right barrel extension, which engages first the safety lock and then the firing pin actuating lever in the bolt, causing the round to be fired. The right bolt, left barrel, barrel extension, recoil cylinder, and loader-operating cam all recoil by blowback, compressing the left barrel recuperator spring and forcing oil through the orifices in the recoil piston rod. The bolt extracts the expended cartridge case when its base strikes the right ejector near the end of recoil. At the limit of its recoil, the barrel extension strikes the recoil buffer and engages the top sear which holds the extension in its full recoil position.

During its initial recoil movement, the left barrel extension strikes the lever on the right sear latch trip slide and moves the slide downward to the rear. The rear end of the slide contacts the roller on the end of the lower right sear latch, disengages the latch from the bottom sear, and allows the right barrel, barrel extension, and left bolt to move forward. During recoil of the left barrel extension, the loader-operating cam, upon which the loader winding mechanism follower rides, causes the winding ratchet pawls to move upward in position to engage the spring-winding ratchet wheels.

The cycle described above repeats as the left bolt, right barrel, and barrel extension move forward, and

continues to repeat as long as the firing lever is held in the firing position or until both loaders become empty.

When the last round leaves the left loader, pressure of the round against the lever is relieved, and the left interlock rod is allowed to move forward through the action of the lever of the loader. Movement of the interlock rod forward causes the lock to move into engagement with the lever on the slide. After the round is fired, the right barrel extension recoils, trips the upper left sear lock, and is locked in the full recoil position by the bottom scar. The left barrel extension moves forward over the slide and the lever to fire the last round from the right loader. Since the lever is held down by the lock when the left barrel extension recoils, the barrel extension does not strike the lever and move the slide rearward to trip the lower right sear lock. Both barrels and extensions therefore remain locked in the full recoil position after the last round is fired.

If no further firing is to be done, both barrel recuperator springs may be released by actuating both the firing lever and the lever which will trip all sear locks and allow both barrels to move forward against the front buffer.

SECTION 2. 50-MM PAK

General Data

Caliber: 50-mm.
Rate of fire: 80–120 rounds/minute.
Muzzle velocity: 2,740 feet/second.
Muzzle energy: 265 foot-tons.
Chamber pressure: 40,000 psi.
Gun weight (recoiling mass): 550 pounds.
System of operation: Recoil.
System of locking: Dropped breech.
System of feeding: Clip (can be converted to automatic feed using metallic belt).
Method of charging: Hydraulic.
Method of cooling: Air.
Barrel removal: Not quick change.
Bore:
Number of grooves: 8.
Direction of twist: Right hand.
Form of twist: Constant.
Method of headspace: Factory established.
Location of feed opening: Top.
Location ejection opening: Rear.
Projectile weight: 4.54 pounds.

General Description

The 50-mm Anti-tank Gun is air-cooled, recoil-operated, clip-fed, and uses percussion-primed ammunition. This gun was developed to provide a simple form of magazine-fed automatic gun utilizing the force of recoil to load the round on to a loading tray and to set a spring-loaded rammer.

During the firing tests a cyclic rate of 80–85 rounds per minute was obtained. The designer of the automatic loader stated that he hoped to obtain a rate of 100 rounds per minute and was confident that with further trials and redesign, the gun would be able to fire at a rate of 120 rounds per minute.

This gun is very simple and has a small number of parts which may be divided into two groups: the fixed parts and the recoiling parts. The breech operating mechanism is particularly interesting and was considered by the Germans to be worthy of further development.

Detail Description of the Nonrecoiling Parts

The principal fixed parts are: gun housing and cams, loading mechanism, rammer housing, and firing lever.

Gun Housing. The gun housing contains a mounting for the recoil system at the front end. The breech ring is pinned to the recoil system (hydro-pneumatic).

Loading Mechanism. The loading mechanism is fastened to the top of the open portion of the housing. The loading mechanism is actuated by the cam surface on the top right of the breech ring. As the gun recoils this cam surface causes the feed arm to move to the right while the magazine is held by the catches. During counter-recoil, the feed arm moves to the left under the action of the feed arm return spring and indexes the clip, stripping another round to the loading position. There is a safety catch located at the rear of the loader which prevents the rammer from moving forward when the last round has been fired.

Rammer. The rammer housing is fastened to the inside of the left wall of the housing. The rammer housing is tilted so that the rammer is clearly above the bore when it nears the rear end of its travel, thus affording clear ejection path.

The rammer is moved to the rear by the breech ring during recoil and is held there by the sear.

Sear. This sear has two catches. The front catch is operated by the firing lever. The rear catch is attached to the cam which is struck by the lowered breechblock as the recoiling parts come into battery. The rammer is held by the rear catch until the came is moved forward; it then moves forward until it is held by the front catch. This double catch system prevents a round being rammed unless the gun is forward and the breechblock lowered. The hand lever also operates the rear catch.

Firing Lever. The firing lever is connected by a long rod to the roller and is also keyed to the front catch operating mechanism. Operation of the firing lever draws the roller to the rear, moving the firing pin sear and releasing the firing pin. As the gun moves into battery, the breechblock is lowered and the roller strikes the front face of the block. The roller is spring-loaded and moves forward with the block until it is fully forward. When the block rises the roller moves rearward under the block and strikes the firing pin sear lever. Thus the firing pin cannot be released until the block is fully closed.

Single or Automatic Fire. Single and full automatic fire are controlled by a device located just to the rear of the firing lever, which governs the length of travel of the firing lever. For full automatic fire, the lever movement is limited in order to hold the front sear catch depressed. For single fire, the firing lever moves farther, depressing then releasing the front catch.

Detail Description of Recoiling Parts

The principal recoiling parts are: barrel, breech ring, breech-operating mechanism, breechblock, rammer, and loading tray.

Breech Ring. The breech ring is attached to the barrel receiver and contains the breech operating mechanism. The loading tray is attached to the rear of the breech ring.

The feed operating cam is located on the top right of the breech ring. The rammer buffer is on the rear left of the breech ring.

Breech - Operating Mechanism. The breech-operating mechanism is pinned to the bottom of the breech ring. The breech is spring-operated, both in opening and in closing.

The housing contains all the parts required to operate the breech. The gear rack and the breech closing spring slide over the shaft. The nut screws on the shaft, compressing the closing spring and forcing the gear rack to the rear against the shoulder. The nut bears against the housing and provides initial compression of the closing spring and also limits the travel of the shaft to the rear.

The breech opening springs fit inside the shaft. The bolt screws into the housing and forces the shaft and its shoulder against the gear, tending to move it forward and open the breech.

When the springs and rack are in the housing and the breechblock is raised, the shaft, the rack, and the closing springs are forward. The shaft then protrudes the maximum amount from the front of the housing.

As the gun comes into battery the shaft strikes a fixed pad on the gun housing and is held stationary as the breech ring continues to move forward. This causes the shaft to move rearward relative to the housing and compresses the breech opening spring. When the shaft is fully back, the catch slides down and bears against the forward face of the shoulder on the shaft. This locks the shaft to the rear and keeps the opening spring compressed.

Meanwhile, the breechblock has been held down by the extractors; therefore, the operating arm, the gears, and the gear rack have also been locked in position. Since the gear rack cannot move and the shaft and the collar have moved to the rear (relatively), the breech opening spring is compressed and stores the energy required to open the breech.

When a round enters the chamber and trips the extractors, the operating lever, gears, and gear rack are free to move under the action of the closing spring. The spring then forces the rack to the rear until it strikes the shoulder on the shaft. This causes the gear to rotate and turn the operating shaft, thereby raising the breechblock.

During recoil, the lug on the shaft of the catch strikes a cam on the bottom surface of the gun housing. This causes the lug to rotate and withdraw the catch from against the shoulder on the shaft. The breech opening springs which were held

compressed then force the shaft and the gear rack forward causing the operating lever to rotate and open the breech. The front end of the shaft then protrudes from the housing and is in position to be struck as the gun returns to battery.

Hand-Operating Mechanism. If the gun is in battery and the breech is closed, it may be opened by means of the hand crank. This hand crank is geared to a rack which in turn operates a gear having a lug that will bear against the cam. Rotation of the hand crank causes the gear to rotate and move its lug against the cam and cause it to rotate. This cam is keyed to the shaft of the operating lever and thereby lowers the breechblock. This rotation of the operating lever causes the gear to rotate and move the gear rack forward, compressing the breech closing spring since the front end of the shaft is against its pad.

Breechblock. The breechblock is of the vertical sliding type, having a percussion-type firing pin.

The internal breech operating lever is pinned to the breech operating lever located in the breech operating mechanism. As the breechblock is lowered the lever is caused to rotate first counter-clockwise and then clockwise. The counter-clockwise movement causes the cocking lever to rotate and withdraw the firing pin against the firing pin spring until it is caught by the firing pin sear.

The block is then raised and the lever goes through the same rotation (directions reversed). When the block is fully raised the sear lever is in position to be acted upon by the firing lever roller. The roller causes the sear lever to move to the rear which causes a rotation of the sear, raising the rear end and releasing the firing pin.

If the gun is firing full automatic, the lever is held to the rear. This causes the firing lever roller to be held to the rear. As the gun comes into battery the block is lowered and the roller strikes against the cam surface on the front of the breech block. The roller is spring-loaded and moves forward a short distance with the block. As the gun comes into battery the block is lowered and the roller strikes against the cam surface on the front of the breechblock. The roller is spring-loaded and moves forward a short distance with the block. As the block is raised the roller follows the cam until it strikes the sear lever and causes the gun to fire.

The cam surface is the part of the breechblock that strikes the cam which operates the rear catch of the rammer sear.

The cam surfaces are the surfaces which operate the extractors.

The firing pin may be hand cocked by rotation of the lever.

Loading Mechanism. The loading mechanism is of very simple design and is recoil-operated.

Manually Charging the Gun

When the gun is in battery and the breech is closed, it is charged by means of the hand crank. This hand crank is geared to a rack which in turn operates a gear having a lug that will bear against the cam. Rotation of the hand crank causes the gear to rotate and move its lug against the cam. This cam is keyed to the shaft of the operating lever and thereby lowers the breechblock. This rotation of the operating lever causes the gear to rotate and move the gear rack forward, compressing the breech closing spring since the front end of the shaft is against its pad.

Cycle of Operation

The operation of the weapon will be described in two parts, the recoiling and counter-recoiling movements.

Recoiling Movement. Upon firing of the round, the gun-barrel and breech ring move to the rear in recoil. The loading mechanism is actuated by the action of the cam surface on the feed arm causing a round to be indexed to the center position, during counter-recoil.

During recoil, the lug on the breech operating mechanism strikes the cam on the bottom surface of the gun housing and causes the breechblock to lower and eject the empty cartridge case. The firing pin is also cocked on this motion of the breech-block.

The rammer head is in contact with the breech ring during recoil and is forced back to the rammer catch by the breech ring.

The recoiling parts are then stopped by the recoil mechanism and start forward under action of the counter-recoil system.

Counter-Recoiling Movement. The gun barrel

and breech ring move forward and, as they approach battery, the shaft of the breech-operating mechanism strikes a fixed pad and charges the breech-operating springs.

The cam is struck by the cam on the lowered breechblock as the gun moves into battery. This releases the rear rammer catch and the rammer moves toward its front catch.

If the firing lever is on FIRE, the front catch is depressed and the rammer moves forward to ram the round. The firing lever roller is forced against the cam on the lowered breechblock.

As the round enters the chamber, it trips the extractors and the breech closes. The roller follows the cam path and strikes the firing lever and fires the round.

SECTION 3. 55-MM FLAK

General Data

Caliber: 55–mm.
Rate of fire: 100–140 rounds/minute.
Muzzle velocity: 2,740 feet/second.
Projectile weight: 4.54 pounds.
Muzzle energy: 265 foot-tons.
Chamber pressure: 40,000 psi.
Gun length (traversing mass): 257.9 inches.
Gun weight: 550 pounds.
System of operation: Recoil.
System of locking: Dropped breech.
System of feeding: Feed tray conveyor.
Method of charging: Manual.
Method of cooling: Air.
Weight of feed tray with 4 rounds: 57.2 pounds.
Barrel length: 185.13 inches.
Barrel removal: Not quick barrel change.
  Direction of twist: Right hand.
  Form of twist: Constant.
Method of headspace: Factory established.
Location of feed opening: Top.
Location ejection opening: Rear.

General Description

This 55-mm fully automatic anti-aircraft gun was initiated at the request of German authorities. It was designed to use a type of auto loader similar to that used on the 75-mm FLAK R4, described in the following section.

SECTION 4. 75-MM FLAK R4

General Data

Caliber: 75-mm.
Rate of fire: 75–100 rounds/minute.
Muzzle velocity: 2,950 feet/second with 13.9-pound projectile; 3,020 feet/second with 13.2-pound projectile.
Range: 53,500 feet.
Gun weight: 1,750 pounds.
System of operation: Recoil operated (hydraulic pressure stored during recoil).
System of locking: Horizontal sliding breech.
Recuperator system: Air.
System of feeding: Automatic.
Method of charging: Air or hydraulic.
Method of cooling: Air.
Barrel length: 172.2 inches.
Type of barrel: Jacket with removable liner.
Bore:
  Direction of twist: Right hand.
  Form of twist: Constant.
Method headspace: Established at factory.
Location of feed opening: Top.
Location ejection opening: Rear.

General Description

The 75-mm Flak R4, developed by the Skoda Works, is a fully automatic anti-aircraft gun, hydraulically operated and controlled by pressure created and stored during recoil. The breech is both opened and closed by springs charged during the final return to battery. The system incorporates a compact fuze setter.

Detail Description

Gun. The tube has a replaceable liner. The gun rides on ways and is retarded in its rearward motion by a constant force hydraulic recoil system and a compressed air recuperator. The breech is closed by a conventional horizontal sliding breechblock. The principle of operation of the breech-

block is the same as in the Skoda 50-mm PAK. The breech opening and closing springs are compressed by the charging rod striking the pad as the gun comes into battery. The extractors prevent the block from closing under pressure of the closing spring until the round is rammed. On recoil the

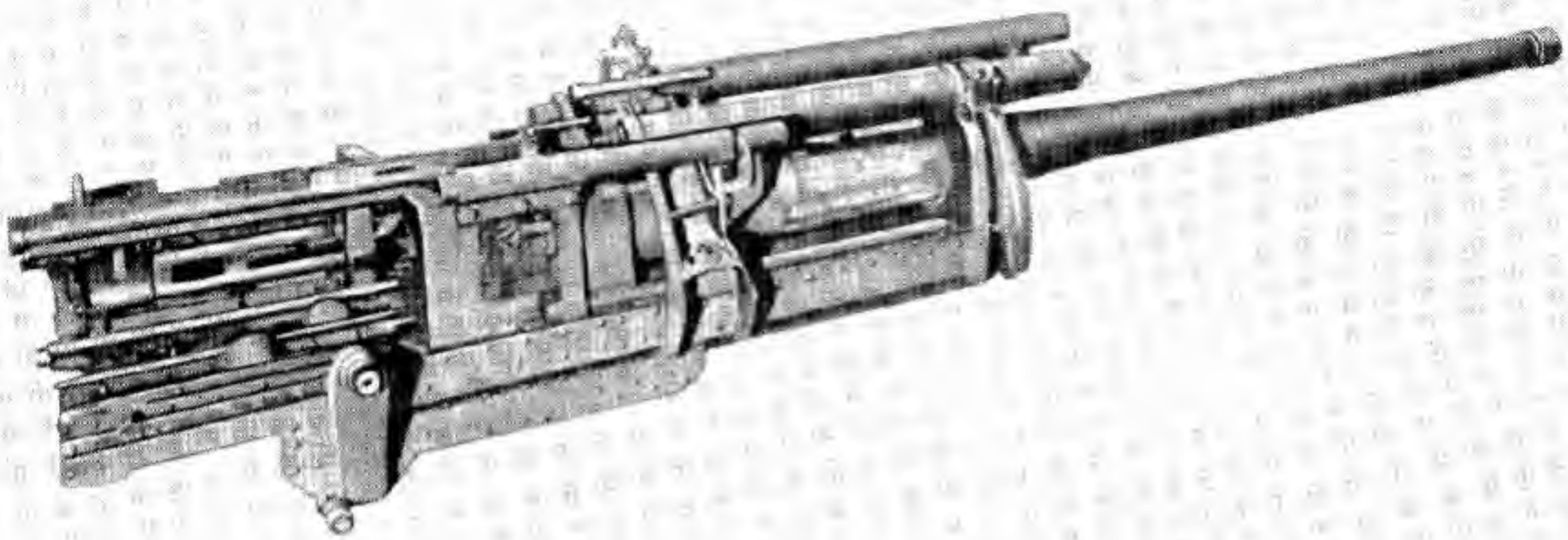

Figure 7–8. Right side view of the Skoda 75-mm Automatic FLAK R4.

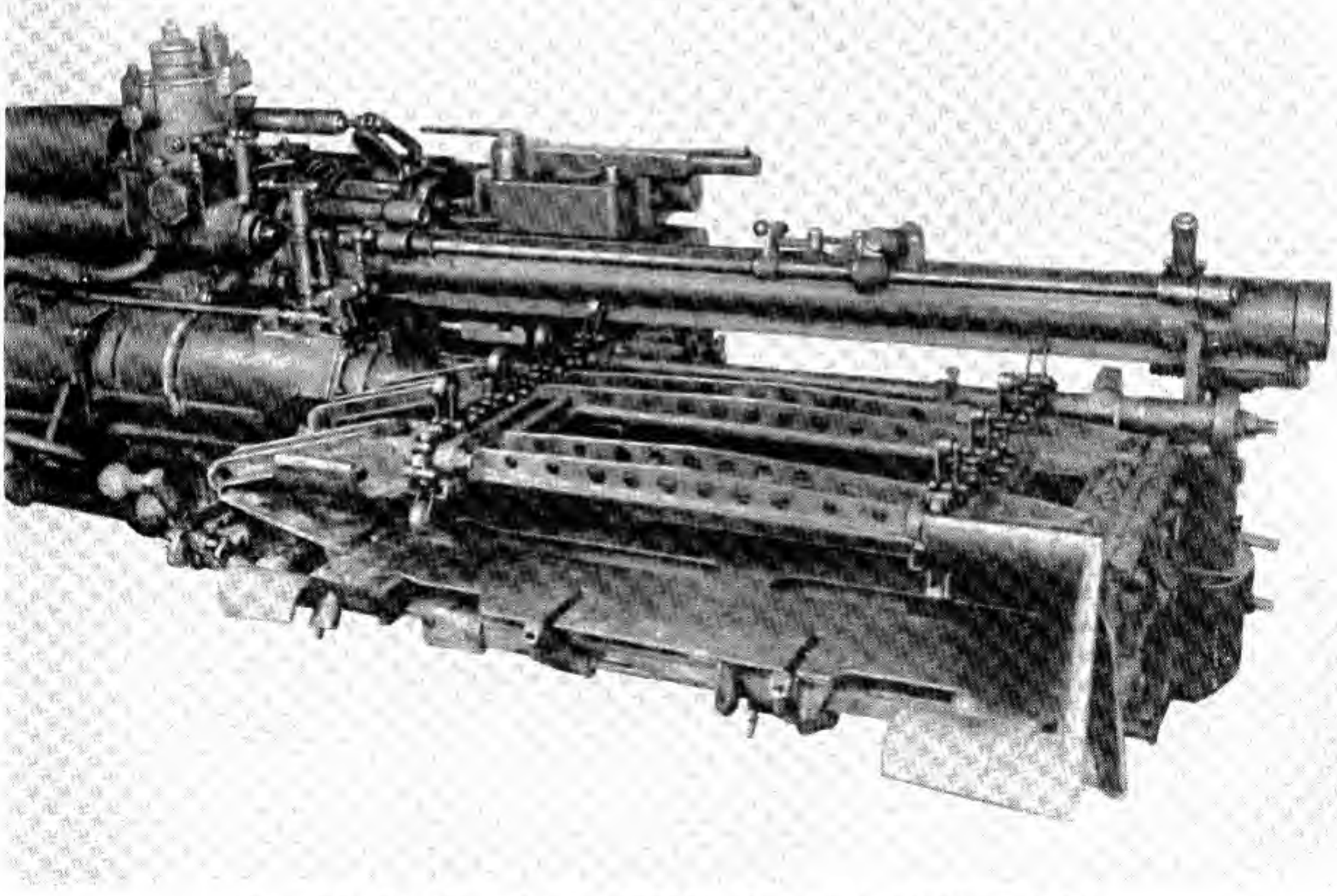

Figure 7–9. Skoda 75-mm Automatic FLAK R4. View of the feed device from the left.

breech-opening release lever overrides the breech-opening release cam. On counter-recoil the release lever contacts the release cam thereby unlocking the spring and opening the breech.

The breechblock may be hand operated by the lever, provided that the automatic fire plunger is depressed so the lever and operating gears are connected. A lever is provided to trip the extractors so rounds may be loaded and fired manually.

Feed Mechanism. The feed mechanism consists of a feedway, a feed tray, round conveyer and operating rack. The feedway is a guide for the rounds and has a capacity of three rounds which are indexed by the conveyer. Including the round in the feed tray, the total capacity is four rounds. The conveyer may be hand operated to load it initially. Under automatic operation the conveyer indexes a round onto the tray as the tray is returned outboard after ramming. The feed tray is hydraulically operated by the tray operating rack. When pressure is applied to the tray operating piston such that the rack is driven rearward, the tray is driven in line with the bore through a series of gears. The tray, fuze setter and rammer are interlocked so the operation of each occurs at the proper time during the cycle.

Rammer. The rammer is hydraulically operated. It consists of an arm secured to the end of a piston rod. The end of the rod rides on rollers in the rammer housing. The piston end of the rod is contained in the rammer cylinder and is driven rearward or forward by hydraulic pressure applied to the proper side of the piston through the control valve. The rammer arm is free to rotate through a limited

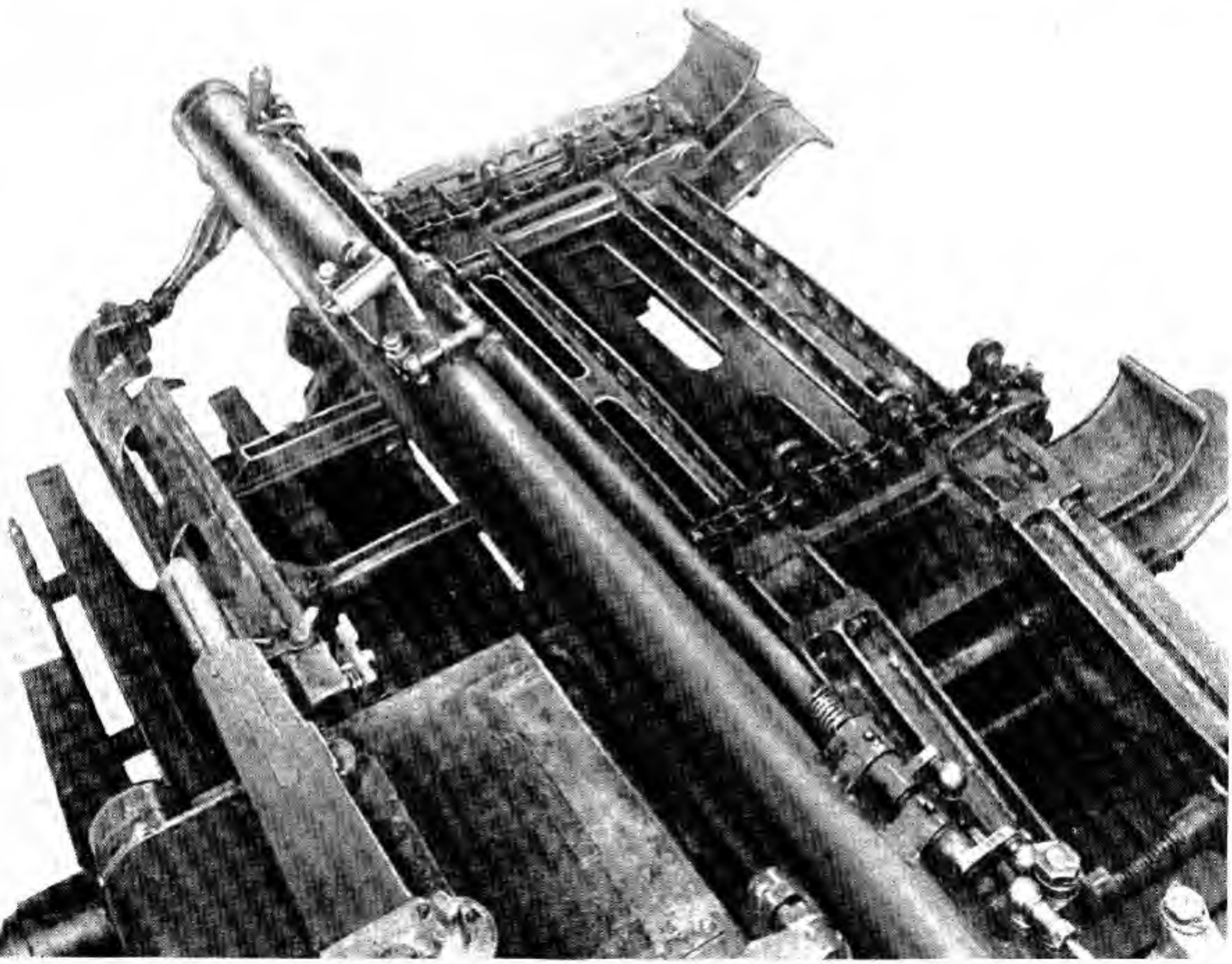

Figure 7-10 Skoda 75-mm Automatic FLAK R4. Top view of rammer and feed mechanism.

arc. As the tray moves in line with the bore a roller at the extreme rear of the tray engages the rammer arm and rotates it outward so the head is positioned behind the round. Upon reaching its "in line" position, the tray, through a linkage, operates the control valve and the round is rammed by the hydraulic pressure acting on the piston. Since the rammer and breech do not recoil together the rammer head must be positioned out of the way before firing. As the breechblock closes on the rammed round, a projecting rod on the breechblock contacts the rammer arm and rotates it out of the path of the recoiling gun.

Fuze Setter. The fuze setter is hydraulically operated by pressure through the control valve to the proper side of the piston. In setting the fuze, the fuze setter cup is driven rearward to engage the setting ring of the round. The cup then rotates the setting ring the required amount. The amount of rotation is preset by the handwheel and indicated by the dial. Each succeeding round will be set for the same time unless the handwheel is rotated.

Firing Mechanism. The rounds are percussion fired by a firing pin spring-loaded in the retracted position. The firing pin is operated by the firing pin actuator, which in turn is actuated by the spring-loaded firing plunger. As the gun comes into battery, the top projection of the sear engages the lower lip of the firing plunger and drives it forward compressing its spring. When the tray is returned to the outboard position, the sear actuator operating lug secured to the tray operating rack causes the operating linkage to rotate and depress the sear actuator. This actuator has an arm which engages the side projection of the sear and the firing plunger is released, firing the round.

Hydraulic Control System. The hydraulic control system is the heart of the weapon. The control system consists of an operating cylinder and piston, intermediate cylinder and floating piston, spring operated control valve which functions at the proper time during the automatic cycle. The cylindrical control valve properly controls the eight ports in each of four valve positions. In positions 1, port 6 is connected to port 5, and 1 is connected to 4. In position 2, port 6 is connected to port 7, and 1 is conected to 2. In position 3, port 2 is connected to port 3, and 7 is connected to 8. In position 4, port 3 is connected to port 4, and 5 is connected to 8. The valve allows the oil pressure to act upon the various operating pistons such that the resultant force (pressure time net area) acts to drive the piston in the proper direction. The valve is allowed to rotate through 90 degrees each time it is released. It is positively stopped in positions 1, 2, and 3. In position 4 it is stopped momentarily and then by the

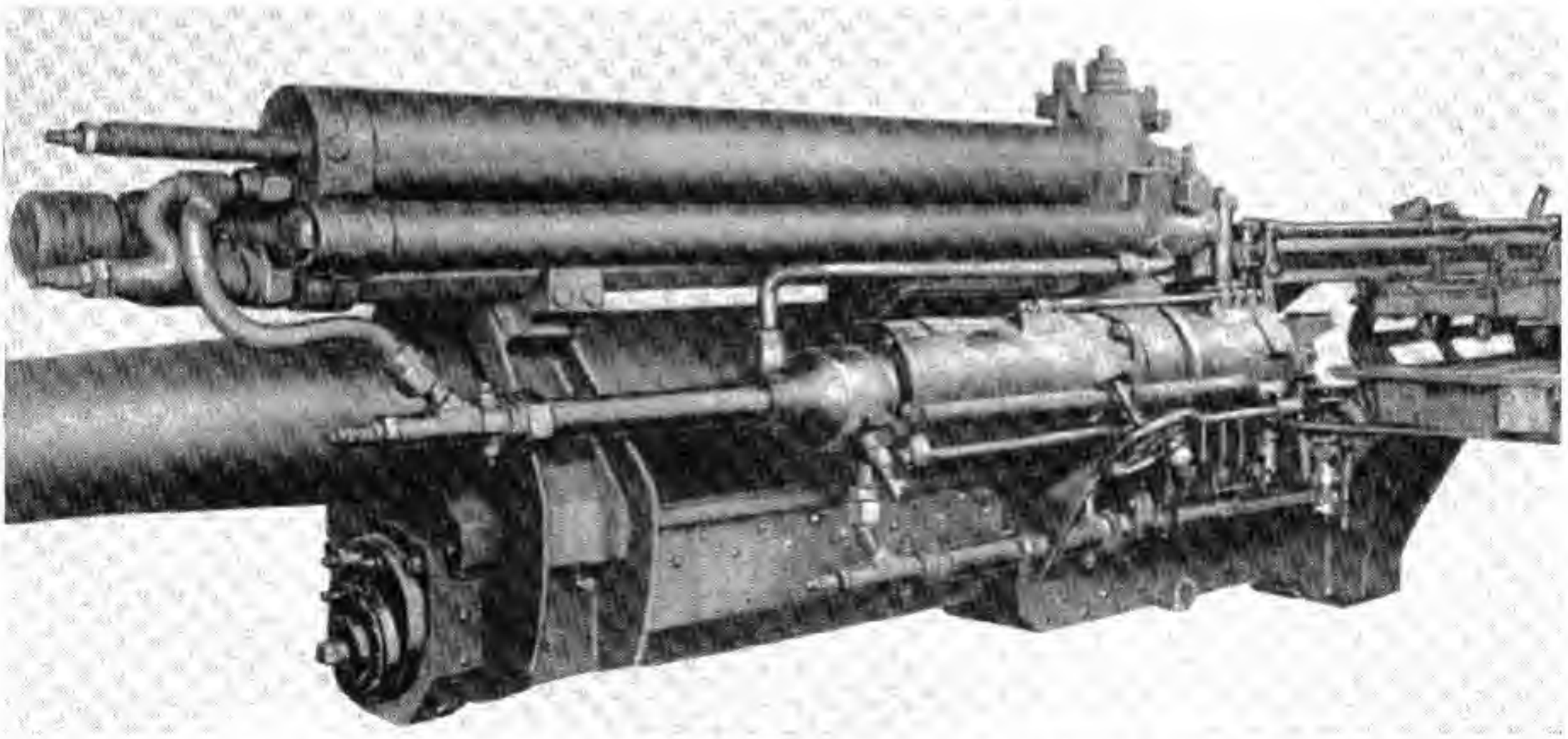

Figure 7-11. Skoda 75-mm FLAK R4. Close-up view of the hydraulic control system.

force of the coil spring, the valve slips on to position 1. The coil spring is initially wound manually. It is rewound each cycle by a rack and pinion arrangement. When the gun comes into battery the stop, secured to the breech-ring, contacts the control valve spring winding rack. This rack is geared to a pinion whose shaft operates to wind the control valve coil spring. At the same time the rack return spring is wound so upon recoil of the gun, the rack is returned to its original position.

The high pressure fluid which the control valve routes to the proper pistons is stored in the reservoir. The reservoir contains an initial supply of compressed air and oil. The reservoir is directly connected to the intermediate cylinder. The floating piston separates the actual operating oil from the compressed air and oil in the reservoir. The intermediate cylinder is connected through a one way valve to the operating cylinder. The operating cylinder contains a piston and rod. The front of the operating cylinder is equipped with a one way air valve which opens readily on rearward travel of the piston but acts as an orifice type brake on return of the piston. The rear of the operating cylinder piston rod is connected to the breech ring by a yoke. The gun will drive the rod rearward, but the rod is free to remain rearward while the gun returns to battery. On recoil of the gun after firing, the operating piston rod is driven rearward and the oil is displaced through the one way valve and into the intermediate cylinder driving the floating piston forward and further compressing the air supply in the reservoir. Thus a pressure supply is available for operation during the cycle. The

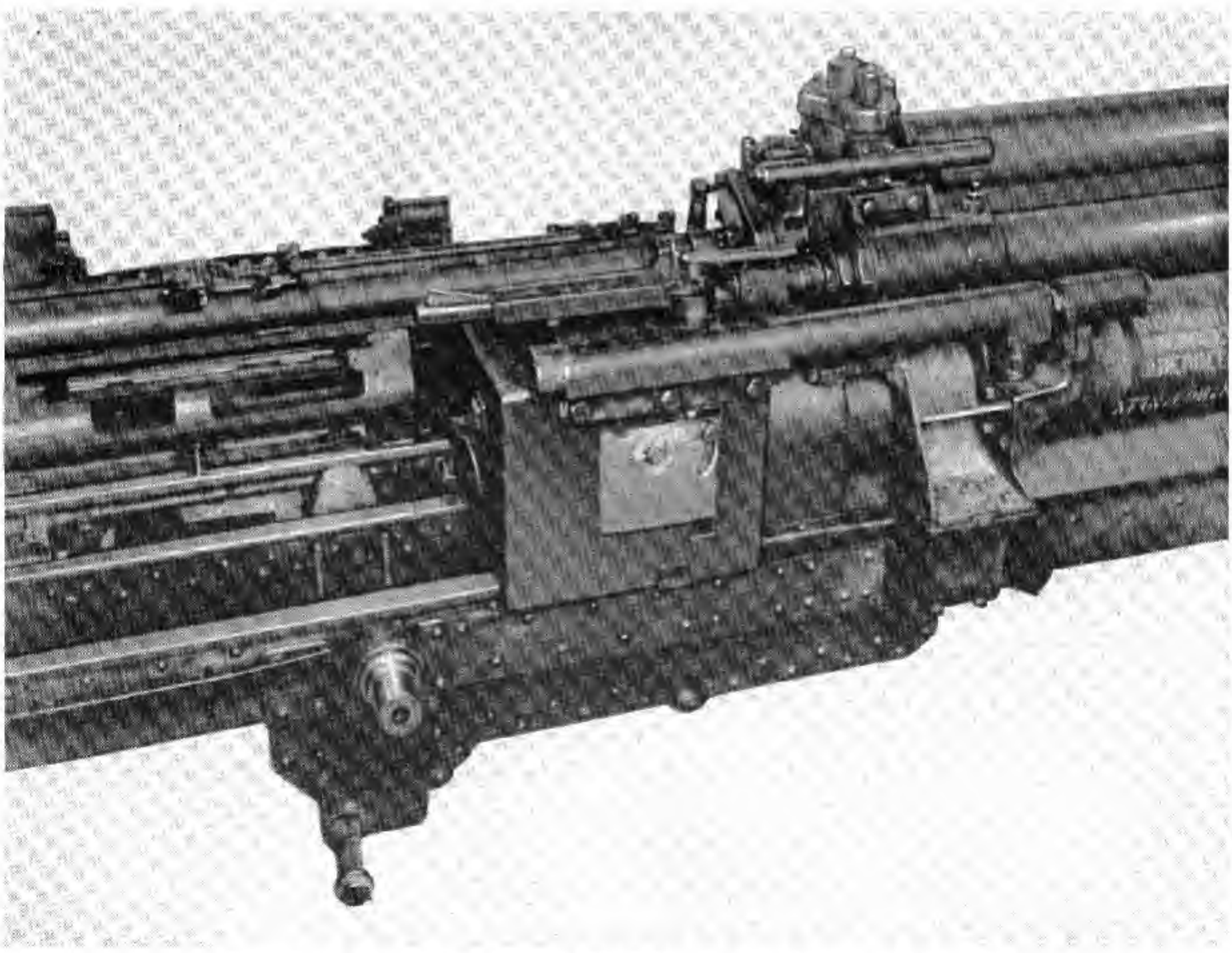

Figure 7-12. Skoda 75-mm Automatic FLAK R4. Close-up of breech from the right.

operating piston rod is retained rearward by the retainer until it is released to allow for return of oil to the operating cylinder.

Automatic Operation

The initial condition of the various elements of the gun just as it fires is as follows: The gun is in battery. The breechblock is closed upon the round and the breech opening springs are compressed. The feed tray is outboard with a new round held in it. The rammer piston is forward, and the rammer arm is rotated out of the path of the gun. The operating piston is forward and the floating piston is rearward. The fuze setter piston is forward. The control valve is in position to connect port 5 to port 6 and 1 to 4. After the round is fired, the gun recoils and the force is absorbed mainly by the constant force fluid recoil mechanism and the compression of the high pressure air in the recuperator. The operating piston rod is pulled rearward by the yoke secured to the breech-ring, and the retainer engages the head of the rod and holds it rearward while the gun returns to battery. As the gun returns to battery, the breech-opening release lever contacts the breech-opening release cam and the breech-opening spring is unlocked and the breechblock opens. The extractors are rotated and the empty case is ejected rearward. The breechblock spring charging rod contacts the pad as the gun comes into battery; the breech-opening and closing springs are compressed.

The oil in the operating cylinder is displaced by the recoil movement through the one-way valve and into the intermediate cylinder. The floating piston is forced forward and the compressed air in the reservoir is further compressed. The pressure also forces oil out of the intermediate cylinder through port 5, into the control valve and through port 6 to the front of the rammer and fuze setting pistons. The great area of the front of the pistons results in rearward motion. The rammer is thus driven rearward and held by the rammer catch. The fuze setter cup is also driven rearward until it engages the setting ring of the fuzed round at which time further rearward movement of the piston causes the cup to rotate the setting ring to the setting time as controlled by the handwheel. After the fuze is set the moving piston rod operates a yoke in the fuze setter which acts to drive the operating rod forward and to release the feed tray interlock. The operating rod engages and rotates the control valve operating shaft. Thereby the operating piston release linkage causes the operating piston retainer to release the operating piston rod. The return spring causes the operating rod and retainer to return to original position. The rotation of the control valve which rotates 90 degrees to position 2 which connects port 6 to port 7 and 1 to 2. Fluid under pressure in the intermediate cylinder goes through port 1, through the control valve, through port 2 and into the tray operating cylinder. The larger front area of the tray operating piston results in the tray operating rack moving rearward displacing the fluid back into the intermediate cylinder.

The control valve release linkage pivot overrides the lug on rearward movement of the operating rod. By means of the rack and pinion the feed tray, carrying the round held by locked spring clips, is moved into the line of the bore. The spring clips are unlocked by striking a projection of the breech ring. The rammer arm is rotated into the line of the bore by the moving feed tray. At the same time fluid pressure from the intermediate cylinder drives the fuze setter cylinder forward and the fluid is displaced through port 6, the control valve and port 7 and into the operating cylinder.

When the tray operating rod has moved the tray into the line of fire, the operating rod continues its rearward movement. This last movement causes the rammer release operating lug to engage a rod which rotates two pivots. The pivot raises the sear actuated so it is free to rotate inward (under its own spring pressure) to a position above the side lug of the sear. The other pivot rotates and through the linkage the rammer arm is released. The direct pressure from the intermediate cylinder acting on the rear of the rammer piston drives it forward and the fluid in front of the piston is displaced through the control valve, via ports 6 and 7, into the operating cylinder where the piston is free to go forward. The rammer arm drives the round, trips the extractors, and the breechblock is snapped closed by the compressed breech-closing spring. The rammer arm is rotated out of the path of the breech by the closing breechblock.

As the rammer head reaches the end of its forward travel, it contacts control valve operating plunger which rotates the control valve operating shaft and

the control valve is released to rotate 90 degrees to position 3. Pressure from the intermediate cylinder acts on the rear of the tray operating piston and drives it forward. The fluid is displaced through the control valve via ports 2 and 3 and into the operating cylinders.

The feed tray is driven outward by the rack and pinion. As the tray nears the end of its outward travel, the round conveyors index another round onto the feed tray. As the tray operating piston nears the end of its travel, the control valve release operating lug on the shaft engages and rotates the linkage and the control valve operating shaft is rotated allowing the control valve to rotate 90 degrees to position 4. Position 4 connects the intermediate cylinder with the operating cylinder through ports 5 and 8. This releases any pressure remaining in the rear of the intermediate cylinders. The valve is not positively positioned in position 4 and it slips into position 1.

The sear actuator operating lug on the tray operating shaft contacts the pivot arm which draws the sear actuator downward and engages the side projection on the sear and the spring loaded firing plunger is released. The firing pin actuator strikes the primer, firing the round.

SECTION 5. 75-MM RECOILLESS AIRCRAFT CANNON

General Data

Caliber: 75-mm.
Muzzle velocity: 2,535 feet/second.
Gun length: 187 inches.
Gun weight: 1,430 pounds.
System of operation: Recoilless principle.
System of feeding: Revolving drum.
Method of charging: Spring rammer.
Method of cooling: Air.
Bore:
Number of grooves: 8.
Direction of twist: Right hand.
Form of twist: Constant.
Location of feed opening: Top.
Location ejection opening: Barrel pivots in center.
Type of ammunition: Fixed.
Type of charge: Ngl M. 36.
Projectile weight: 9.24 pounds.
Charge weight: 4.62 pounds.

General Description

This was a development project for a 75-mm high velocity gun for mounting in aircraft and to have automatic feed. In order to reduce recoil to a minimum, the design called for twin rear venturis, as in recoilless guns, and a muzzle brake.

The gun was to employ a revolving drum-type magazine and spring rammer operated by means of mechanical linkages and ratchet and spring assemblies, power being supplied by gas take-off from behind the rear part of the muzzle brake.

A conventional cartridge with electric primer was to be employed.

The venturis were to be at 30 degrees to the axis of the bore with the throats just forward of the front edge of the cartridge case.

Chapter 8

7.92-MM POWER-DRIVEN MACHINE GUN ZB–80

History and Background

For the design of the 7.92-mm power driven machine gun ZB–80, credit is due the Czechoslovakian arms producing company of Ceskoslovenska Zbrojovka Akciova Spolecnost v Brne, of Brunn, which is popularly known as Brno ZB or ZB because, obviously, of the unwieldy official name of the company. This plant was established after World War I when the victorious Allies were interested in the establishment of a small-arms manufacturing plant on a par with the Skoda facilities for making heavy armament. The location at Brunn was decided on as a factory already in existence there had previously made weapons and two-cylinder automobiles. In 1922, the plant was converted to small arms production by a combination of funds; 75 percent of the stock was held by the Czech Government, 20 percent by the Skoda Works and 5 percent by employees of the ZB plant.

France extended a helping hand, as the first machine gun built by the new firm was the Model 1922 light Hotchkiss built through the cooperation of French Ordnance engineers who had been ordered to turn over to the new company their latest drawings on this machine gun. In 1924, ZB introduced a prototype weapon (ZB 24) of their own design, officially identifying it by the year of its appearance. This weapon was a composite of many sound automatic weapon principles that had been proved by combat in other guns, such as Berthier, B. A. R. (Browning), Hotchkiss, and Chatellerault. A demand for a light machine gun by the Czech Army gave the company the needed opportunity for which it had been waiting, and from that time on the ZB Company has progressed in unbelievable strides.

Fortunately for the company, there was a wealth of skilled technicians available to assist in design and fabrication.

The modern and highly efficient ZB Plant was taken over by the Germans early in World War II and operated under the name Waffenwerke Brunn A. G. The Germans, long noted for their low regard for the professional skill of others, especially when compared with their own, admitted that the Czech engineers were producing weapons as fine as any in the world and paid them the unusual compliment of allowing them to continue their production without being completely restaffed by their own engineers. The Wehrmacht had acquired not only two huge manufacturing arsenals but also gun secrets of the Allies which had been developed in the ZB plant since 1922.

With the fall of Germany and the seizure of the Czech plants by the Russians, the Soviets for the first time had in their hands the one factor lacking in their automatic armament program all through World War II—the manufacturing "know how" whereby weapons could be mass produced to a close manufacturing tolerance, and metallurgy and heat treating could replace bulk or mass. Under the domination of the Soviet Union, the ZB facilities furnished arms to the Russians under the designation "Peoples' Enterprise," a suffix widely used for satellite war plants.

The ZB–80 was in the prototype stage at the time of the German invasion of Czechoslovakia. The model, pictures, and drawings had earlier found their way to the United States and a gun of this type had been demonstrated to American authorities. However, data given in this chapter are derived from brochures prepared in the ZB plant.

Evidence is conclusive that the ZB–80 prototype was designed with a 7.92-mm bore for the sole purpose of conducting tests with ammunition that was readily available and comparatively cheap. The prototype included all features necessary for scaling up the weapon to cannon dimensions.

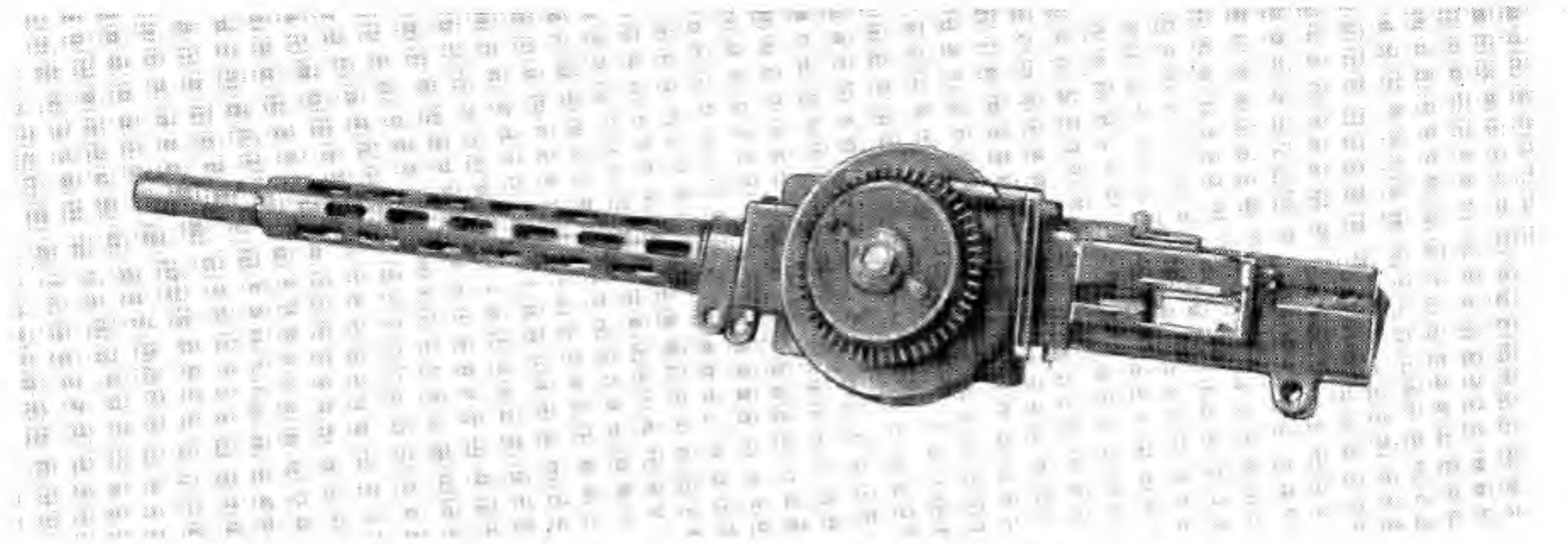

Figure 8-1. Left side view of ZB-80, power-driven machine gun.

General Data

Caliber: 7.92-mm.
Rate of fire: 1,200 rounds/minute.
Muzzle velocity: 2,750 feet/second.
Gun length: 31.1 inches.
Gun weight: 20.9 pounds.
System of operation: Power driven.
System of locking: Camming action (eccentric).
System of feeding: Link metallic belt.
Method of charging: Power derived from outside source.
Method of cooling: Air.
Rate control: Synchronization with airplane's motor.
Barrel length: 24.2 inches.
Weight of carrier frame and transmission: 5.5 pounds approx.
Barrel removal: Quick change.
Method of headspace: Fixed.
Location of feed opening: Top.
Location of ejection opening: Side (cartridge remains in belt during firing and also during ejection).
Weight of one complete belt link: 0.23 ounce.

Description of the Weapon

The ZB-80 represents a departure from the conventional automatic machine gun with synchronized control. This weapon is power driven and its operating energy is derived from an external power source (the airplane's engine) through a mechanical transmission.

Inasmuch as the gun is mechanically driven, it does not require warming up or an independent synchronizing device. These features increase the reliability of the action.

Furthermore, by the simple process of inserting the end of the belt into the belt guide block, the gun is made ready to fire, but there is no live cartridge in the barrel. It follows that there is no hand cycling device or charging movement required.

The belt links are simple pieces of machined steel and are very durable. They are not subjected to distortion or twisting strains and assure accurate functioning of the feed mechanism. The peculiar design of the link in the belt makes it possible to replace the ordinary functions of the breechblock and ejector, and the empty cartridges or misfires are mechanically carried out of the gun, thus eliminating the most common source of stoppage. When firing is interrupted, there can be only an empty cartridge in the barrel, so that pre-ignition by an overheated chamber is avoided.

The weapon cannot be damaged by delayed ignition, because if the delay exceeds the time lag, the barrel is moved off the cartridge and the latter explodes outside the chamber of the gun. Barring instances when unusual deformation of the cartridge case occurs through delayed ignition, it is carried out of the gun by the belt and no stoppage occurs.

The belt chamber has been generously proportioned, as a protection against damage to the main housing (receiver) of the gun by delayed ignition. In the event of the separation of the bullet and case,

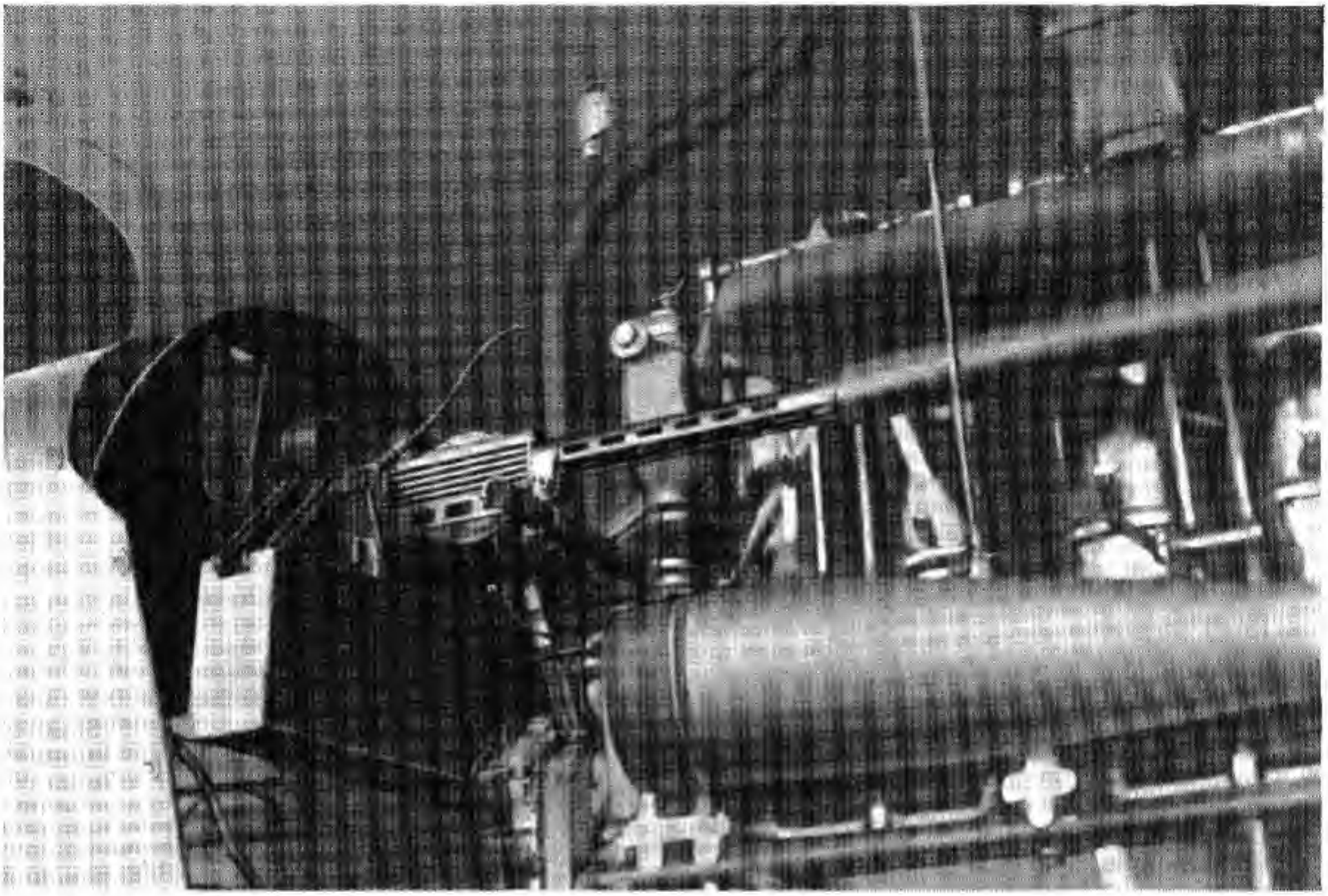

Figure 8 2. ZB 80 Power-driven Machine Gun.

the powder is immediately emptied out of the gun through openings at the rear end of the barrel.

A small angle of dispersion is accomplished by means of the mechanical drive principle, which fixes the firing point for the cartridge at a point which maintains a constant position regardless of the speed of the motor. The light weight and compactness of the gun permit installation in any type of airplane. The simple design permits rapid mounting in any position with respect to the plane. Dismantling the gun can also be accomplished with ease.

By selection of the proper gear ratio between the driving pinion and drive gear, the rate of fire may be brought up to the maximum of 1,200 shots per minute. The mechanical connection of the gun to the airplane engine guarantees uniformity and reliable operation with correct synchronization at all motor speeds.

This gun requires no breech locking mechanism. The mechanical drive connecting the engine to the gun imparts a longitudinal sliding motion to the barrel of the gun and simultaneously acts on the feeding and firing pin mechanism.

The cartridges are retained in a multiple unit flexible steel belt, which feeds them into and out of the gun. The individual units of this belt consist of but two parts, the bottom belt link and the top belt link, which are interconnected with a dowel pin. This pin is an integral part of the bottom belt link, and is locked after inserting the cartridges. After the belt is inserted in the machine gun, it is held in position by the belt holding powls.

The barrel moves on its horizontal axis, guided at the rear in the main housing and at the muzzle by a bearing surface located in the flash hider. The flash hider is connected with the main housing by the barrel sleeve. The flash hider locking spring locks the flash hider, and the barrel sleeve stud locks the sleeve.

This sliding block engages the angular grooves located at the rear of the barrel forming the con-

Figure 8 3. Right side view of ZB-80, showing the unusual design of the belt.

nection between the operating and drive mechanism, and imparting reciprocating motion to the barrel. The breech end is protected by the guard plate.

The crank pin drives the sliding block through the crank pin roller, which engages the crank pin roller bushing and runs in the sliding block slot.

The sliding block, that travels rearward and forward is an eccentric which is governed by the radius of the crank pin throw. After the barrel is locked, the crank pin moves 30 degrees before it starts to move the barrel again. This arrangement insures that the time lags is at least three times as long as the interval required for firing a round when the rate of fire is 1,200 rounds per minute. This type of action prevents pulling a hang-fire.

The drive gear of the ZB–80 is located on the side of the gun and is enclosed in the "crank housing" (receiver) which is attached to the "main housing" with two crank housing bolts which, in turn, are locked in position by the crank housing bolt catch. The roller bearing assembly for the crank disk consists of the crank disk roller bearing race, roller bearing rollers, roller cage, roller retaining plate, and roller retaining plate rivets. The roller bearing assembly contacts the periphery of the crank disk. This bearing, which is of large diameter, gives a considerable distribution of pressure during firing; thus reducing stresses and strains to the minimum.

The coupling for the crank disk is located in the center of the assembly and engages the clutch by means of slots in the clutch spindle, and the power connection is completed through the crank disc driver. One of the arms on the crank disc driver is a little longer than the other; improper assembly is thus less likely.

The clutch spindle ball bearings are enclosed in the crank case cover and held in place by the clutch spindle ball bearing retaining nut. They form the rear bearing for the clutch spindle. The front bearing of the clutch spindle consists of solid bushing. The crank spindle end plate is slipped over the square end of the clutch spindle and is held in position by the crank spindle nut.

The crank spindle end plate, as well as the timing plate which is attached with four timing plate dowels to the driving gear, has meshed gears. The connection between the drive gear and the clutch is by means of the timing ring, which slips over the crank spindle end plate and the timing plate. The drive gear, which is mounted in the drive gear bushing, rotates continuously as long as there is an application of power and transmits the rotation to the clutch through the timing plate dowels. Should an interruption in the functioning of the gun occur, the connection between the clutch and the drive gear is broken by the shearing off of the timing plate dowels.

The timing ring is used to adjust the timing of the gun when it is being mounted in the airplane. When this ring is slipped off in the direction of its axis, the connection between the driving gear and the clutch is broken; thereafter the drive gear and

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the clutch can be shifted in their relation to each other by any desired number of teeth. The timing ring is locked, as is also the clutch spindle nut, against turning, by the timing ring retainer.

The shaft bearings of the operating lever are secured to the crank case over and the crank housing, thus keeping the crank case cover from turning.

The operating yoke is secured to the spindle of the operating lever by means of the operating lever key and the operating yoke set screw. When the operating lever is shifted, the crank disc drive is pushed into contact with the crank disc by the operating yoke, and the machine gun starts to fire. The weapon may be controlled in two ways: (1) by manipulating the vertical arm of the operating lever, which engages and disengages the clutch; and (2) by moving a horizontal arm which engages and disengages the feed mechanism.

The feed mechanism is set in motion by the push rod, which lies on the main housing, and is guided by the main housing top cover. The forward movement is imparted by the sliding block, which is struck on its angled surface by the nose of the push rod, forcing the push rod forward. The return movement is accomplished by a push rod spring and a push rod spring plunger.

The push rod roller is mounted on the push rod and is prevented from falling out by the push rod roller guide, which projects into the slot in the belt feeder carrier driver.

The belt feed carrier drive turns on its shaft and transmits the reciprocating motion imparted by the nose of the push rod to the belt, feed carrier. The latter is mounted in the main housing at right angles to the axis of the barrel and has guideways in the form of slots, and protects the belt feeder.

The feed opening is located in the main housing and is a part of the guide block which is held by belt guide block studs. The belt holding pawl projects through a slot into the belt guide block and engages the cartridges. The belt guide pawl release and the belt stop pawl are located directly behind the bolt guide block. The pawls are attached to their springs by the release nuts and are retained by the release spring. The rear end of the push rod has a cam which operates the belt guide pawl, the release of which is accomplished with a vertical movement of the latch.

The cartridges are normally fed from right to left. To reverse the direction of feed, the belt guide pawl release and belt guide stop release are changed about, and three parts (belt feeder, belt feeder carrier, and belt feeder carrier driver) are replaced by parts of symmetrically reversed design.

Midway on the push rod, there is an elongated tooth which is caught by a projection when it has reached its extreme forward position. A slot in the push rod, into which the tooth on the horizontal arm engages, prevents premature disconnection of the clutch lever and also carries a lower arm, controlling the push rod latch, in which the push rod latch spring is mounted. The feed safety catch, located on the main housing top cover, disconnects the belt feed mechanism.

The firing pin with its main spring is housed in the firing pin tunnel, located along the axis of the barrel. A forked firing pin housing lever, which swivels on its shaft, is located under the firing pin housing. The right fork of the lever is in constant contact with the firing pin housing; the left fork, which has a lug, is in constant contact with the firing pin housing plunger. The firing pin housing spring returns the firing pin together with its component, to its initial position at the end of each burst.

The firing pin sear is located above the firing pin housing plunger, turning of the sear pin readies the firing pin. The firing pin safety device projects with its nose into the path of the sliding block. When the sliding block completes its rearward movement, it presses the plunger back, and the plunger forces the assembly forward through the motion of the firing pin housing lever. The tooth on the left arm of the sear holds back the firing pin, compressing the firing pin spring. When the plunger has completed its rearward movement, the lug on the firing pin housing lever trips the sear, releasing the firing pin. This arrangement greatly reduces the period during which the firing pin spring is compressed, and, of course, serves to lengthen its life.

The rear end of the main housing is closed by the main housing cover, which is locked in place by a spring loaded latch.

Mounting

A front bracket is attached on the framework of the fuselage of the plane.

The transmission for the machine gun drive mechanism consists of a drive pinion, mounted on the side of the bracket and engaging the drive gear of the machine gun. The drive pinion is connected to the engine through a flexible shaft. The gear ratio between the motor and the machine gun is determined by selecting the proper number of teeth on the drive pinion; the ratio in turn imparts the proper rate of fire in relation to the RPM of the power drive.

The trigger release is attached to the bracket in about the middle and is connected through a Bowden cable release to the master trigger on the flying controls. A slot is milled into the head of the trigger release.

The ammunition box is divided in two compartments. The live ammunition assembled in the belt is placed in the right hand compartment, while the empty cartridge cases, still held in the belt, fall into the left-hand compartment. In order to prevent danger to the live cartridges while the gun is firing, the box covers are cushioned with springs.

A blast tube is secured to the fuselage; the muzzle and flash hider of the machine gun project into this firing tube, which carries the powder gases away.

The machine gun is secured to the bracket by two bolts which pass through the front and rear bracket lugs on the weapon and are locked in position with safety catches.

The vertical end of the operating lever rests in the milled slot in the head of the trigger release, thus connecting the machine gun with the master trigger. To time the gun, the master trigger is depressed and locked with a suitable catch mounted on the flying control, and the clutch is turned by hand until the machine gun barrel is in the firing position. The timing ring is then taken off and the rotation of clutch is continued by hand until the desired tooth has advanced to the desired point. The gun is now in the actual firing position. The timing ring is slipped back into place, and the catch on the master trigger released. The clutch is turned a full revolution by hand, thus disconnecting the firing mechanism in order to prevent the possibility of accidental firing.

All that remains to be done is to insert the belt into the machine gun, and the weapon is ready to fire.

Cycle of Operation

The drive gear on the machine gun rotates continuously with the rotation of the airplane engine, as a result of a direct connection between these two parts. When the master trigger on the controls is depressed, the following sequence of actions takes place. The operating lever is shifted by the release on the gun and the operating lever yoke pushes the crank disk driver into engagement with the crank disk. This action completes the connection between the driver gear and the crank disk, which then commences to rotate counter-clockwise. The closing phase of the cycle is completed when the operating lever releases the push rod from the horizontal arm, causing the push rod to be returned to its previous position. The push rod roller then turns the belt feeder carrier driver on its shaft, forcing the belt feeder carrier to one side, and the belt feeder is brought into the engaged position. The crank pin, running in its slot in the sliding block, imparts a reciprocating motion to the sliding block, which is transmitted to the barrel.

As the barrel moves forward, the push rod is picked up by the sliding block, and the bolt guide pawl is depressed by the action of the cam on the push rod against the belt guide pawl release. This action releases the belt, and the feeding mechanism pushes a fresh cartridge into position behind the barrel. The push rod, which is retained in its end position by the horizontal arm on the push rod latch and the belt, is locked by the belt guide pawl and the belt stop pawl.

On the return movement of the push rod, the barrel is pushed over the live cartridge, thus closing the breech. The sliding block pushes back the firing pin housing plunger, and the firing pin housing lever of the firing pin housing, which is connected with firing pin housing plunger, moves forward; the firing pin is caught by the sear, and the firing pin main spring is compressed. Simultaneously, the sliding block engages the lower lever arm of the push rod latch, causing it to rock and release the push rod. The latter flies back and forces the feed mechanism into the ready position.

When the firing pin housing plunger reaches its in-battery position, the lug on the firing pin housing lever rotates the scar on its shaft, releasing the firing pin, which flies forward and detonates the cartridge.

The cycle is thus completed and continues as long as the master trigger is depressed.

When the master trigger on the controls is released, the trigger release forces the operating lever into neutral position. The horizontal arm on the operating lever remains engaged with the push rod until it reaches the slot on the push rod, drops into it and grips it. This action occurs only at the point where the barrel has reached front dead center. The operating lever is then locked in this position by the upper arm of push rod latch.

When the barrel reaches rear dead center, the cartridge in the chamber is fired and the sliding block twists the push rod latch, releasing the operating lever, and the operating lever yoke disengages the crank disk drive from the crank disk.

This action breaks the connection between the crank disk and the clutch of the machine gun.

For loading belts, a loading mechanism is employed, which takes the belt apart, ejects the empty cartridges, inserts live cartridges in the links, and reassembles the belt links.

SAFETY PRECAUTION. Before placing the cartridge belt in the gun it is mandatory that the cartridges be well greased in order to prevent rupturing of the cartridge cases at extremely high rates of fire. The procedure used in this function is to dip a brush in heavy oil or vaseline and oil or grease both sides of the ammunition by a painting process.

Disassembly

A special wrench is sent with each gun. This all-purpose tool together with a loaded cartridge are sufficient for the complete disassembly and assembly of ZB–80 Machine Gun.

The horizontal lever arm is turned until it projects out of the main housing top cover. If resistance is felt, the operating lever is pressed continually, and the drive gear is turned until the crank disk driver can be engaged in the crank disk and the operating lever turned. Then both crank housing studs are extracted and the crank housing detached from the main housing.

The sliding block is moved forward, thus moving the actuating rod in the same direction, and in position to be secured in position by the feed safety catch. The flash eliminator locking spring is turned and the barrel sleeve taken off. The sliding block is unscrewed and removed. The barrel is pulled out of the main housing.

To Disassemble the Belt Feeder. The main housing rear cover is taken off by pressing the main housing rear cover spring to the rear with the thumb of the left hand and pushing sidewise with the right hand until the cover falls off.

The main housing top cover is pushed to the rear as far as it will go and lifted off the main housing.

To free the feed mechanism the push rod pawl must be forced down until its locking projection releases the spring loaded latch. The feed is then lifted up and removed from the receiver. Now withdraw out of recess in the main top cover.

Now the push rod spring, push rod spring plunger, and the push rod are withdrawn out of the recess in the main top cover. The push rod roller cannot be removed from the push rod because the push rod roller guide is riveted. However, the push rod pawls and the push rod latch spring can be lifted out of their housing. Remove the belt feeder carrier.

To further dissassemble this piece, the belt feeder pin is pulled out of the belt feed carrier and the belt feeder is pushed upward. The belt feeder spring and the belt feeder are removed from the receiver.

The belt feed pawls are next released by unscrewing the studs holding them and are taken out in a downward direction. The belt guide releases, along with their springs, are removed by lifting them. After the belt guide lock screw is released, the belt guide block is taken out.

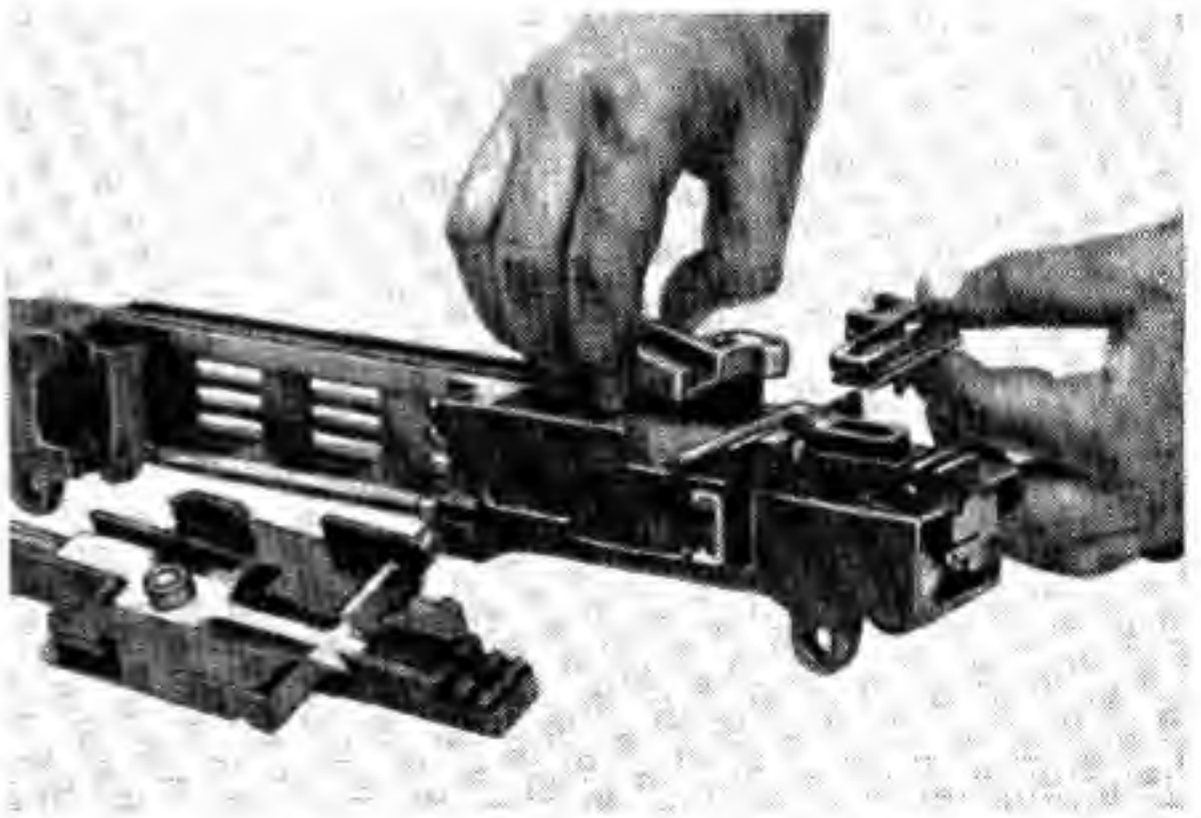

Figure 8–4. Disassembly of feed system of ZB–80 Power-driven Machine Gun.

To Remove the Firing Pin Assembly. To remove the firing pin spring, the firing pin bolt is unscrewed. The sear pin is then rotated and pulled upward. The firing pin housing plunger is forced to the rear and together with all relating components is removed from the main body of the receiver. The firing pin is lifted out of its tunnel and the firing pin spring removed from its housing.

Figure 8-5. Removal of firing assembly of ZB-80 Power-driven Machine Gun.

After releasing the barrel sleeve stud, the barrel sleeve can be screwed off the main housing.

Disassembly of the Drive Gear. Both timing ring retainers are shifted in the direction of the clutch spindle axis. The crank spindle nut is unscrewed and the drive gear, crank spindle, plate, and timing ring are then detached. The operating yoke set screw is screwed out and the operating lever removed by pulling sidewise.

The operating yoke is then taken out with an upward motion. The crank case cover is screwed off, and the crank disk is removed from its housing. The clutch spindle and crank disk drive are taken out of the crank case cover. After the ball bearing retaining nut is released, the clutch spindle, along with its bearing, is removed.

Disassembly of the Drive Gear Bushing. Disassembly is not recommended as the bushing is fitted at the factory in such a manner that it would be next to impossible to duplicate the act in the field.

Preventive Maintenance

When the weapon is completely disassembled it is recommended that the guideways and bearing surfaces be lightly greased and a coating of thin oil applied to the operating parts. The drive gear should likewise be lubricated with vaseline at this time with particular attention paid to greasing the clutch spindle ball bearing, the crank disk, and the drive gear bushing. The recess in the rear bearing of the flash eliminator is filled with grease.

Assembly

To assemble the gun, the steps stated under Disassembly are reversed.

Malfunctions

As a safety precaution, this weapon has two plate dowels incorporated in its drive gear. In the event of a stoppage, these dowels are sheared off and must be replaced before firing can be resumed.

To replace the dowels, the crank spindle nut is unscrewed and the drive gear is removed. The several dowels are replaced by new ones, and the drive gear and crank spindle nut are put back.

If a cartridge becomes wedged because of the explosion of a hang-fire or a de-bulleted cartridge, the barrel is removed so that the belt guide pawl releases can be pressed down and the cartridge belt pulled out of the feedway.

In the event of split cartridge cases, the barrel is taken out and the remaining portion of the separated case is pulled from the chamber with a special tool.

A broken firing pin is replaced by screwing out the firing pin housing lever in the bolt body. This action frees the firing pin housing, which is taken out. Then a new firing pin is inserted in place of the broken one.

Chapter 9

SOVIET AMMUNITION

7.62-mm Ammunition

Soviet rifles, carbines, and rifle caliber machine guns fire a rimmed, bottle-necked 7.62-mm round. Rimmed ammunition is not well suited for use in automatic weapons, but clever gun designing has overcome the drawbacks of this old-style round. The basic cartridge is the Model 1908, or light ball, cartridge; the Model 1930, or heavy ball, cartridge is used for infantry machine guns. In addition to these types, explosive, tracer, incendiary, and other usual kinds of cartridges are made. Many varieties are available in each caliber; however, it is beyond the scope of this book to describe all the existing kinds.

Figure 9-1. Soviet armorers loading belts into a fighter plane.

Figure 9-2. Soviet 7.62 mm cartridge.

Soviet small-arms ammunition has been notoriously poor in quality. Even before the desperate situations which developed in World War II, a drive was started to conserve materials by substituting a steel cartridge case with exterior copper wash for the normal brass cartridges. In the course of the war it was necessary in some instances even to substitute iron cases for those of steel.

12.7-mm Ammunition

The development of the Soviet 12.7-mm cartridge was influenced by the German T. u. F. 13-mm

Figure 9–3. Close-up of a fired case from a Soviet 7.62-mm cartridge.

round used in World War I. The over-all design of the 12.7-mm is excellent. The outside world first became aware of it in connection with reports of the development of the 12.7-mm Degtyarev gun, about 1934. The use of this cartridge was adapted to the series of guns produced by Beresin; two distinct feed belts were developed. (See fig. 9–4.) Because of its introduction into the forces of various Soviet satellites, this cartridge ranks in importance second only to the American caliber .50 as far as world-wide use is concerned. Although nominally of the same projectile diameter, the American and Russian rounds are not interchangeable. The 12.7-mm rounds are produced with a variety of projectiles and are marked with a color code to distinguish them. The 12.7-mm round is shown in figure 9–5, and the fired case is shown in figure 9–6.

NOTE. It is important that personnel handling foreign ammunition obtain all available information on its color code and characteristics. Information compiled during World War II has been superseded in many cases.

The success of Shpitalny rifle-caliber aircraft machine guns led to larger calibers. (See ch. 4.) Because of features of this design, it could not be made to function with the rimless cartridge used in the Degtyarev and Beresin 12.7-mm guns. Accordingly the highly successful 12.7-mm rimless case was converted into a rimmed version having characteristics suitable to only one mechanism. (See fig. 9–7.) The rimless round was applied successfully to several models of two distinct systems of machine guns, but the rimmed round had very limited use in a single ill-fated gun. Whether the gun itself was a failure or the ammunition supply hopeless is not generally known, but the Shvak 12.7-mm played no important part in World War II. The rimmed 12.7-mm cartridge is quite rare, and the gun for which it was developed has passed from the scene.

One method of shipping bulk 12.7-mm ammunition is shown in figure 9–8.

Dual Ammunition Supply

The apparent explanation for the Soviets' use of a dual ammunition supply in wartime is the extraordinary prestige enjoyed by Shpitalny. It is a curious fact that ever since the introduction of firearms into military forces, Ordnance Departments have been stumbling into the dual-ammunition trap, usually in a situation involving a war or national emergency.

20-mm Ammunition

The cartridge case for the Shvak 20-mm ammunition is a Soviet ordnance item that shows evidence of desperate haste in design. It shows few of the outstanding characteristics of the American and European rounds designed for air-to-air combat.

The origin of this cartridge is open to discussion. It bears a physical resemblance to some of the old Gatling cartridges of the nineteenth century, one of

Figure 9–4. Comparison of Soviet 12.7-mm machine guns. Degtyarev (above) and Beresin (below). Although both fire the same cartridge, the feed belts are different.

Figure 9–5. Complete round of Soviet 12.7-mm ammunition.

which is the caliber .75 shown in a catalogue of Kynoch and Co., of Witton, Birmingham, England, for the year 1882. Most of the Russian Gatling guns used the small arms ammunition but it is known that a few of larger caliber were tried. However, figure 9–12 shows the old caliber .75 Gatling round alongside a dimensional sketch of a complete round of 20-mm Shvak ammunition.

Figure 9–6. Close-up of a fired cartridge case from a Soviet 12.7-mm round.

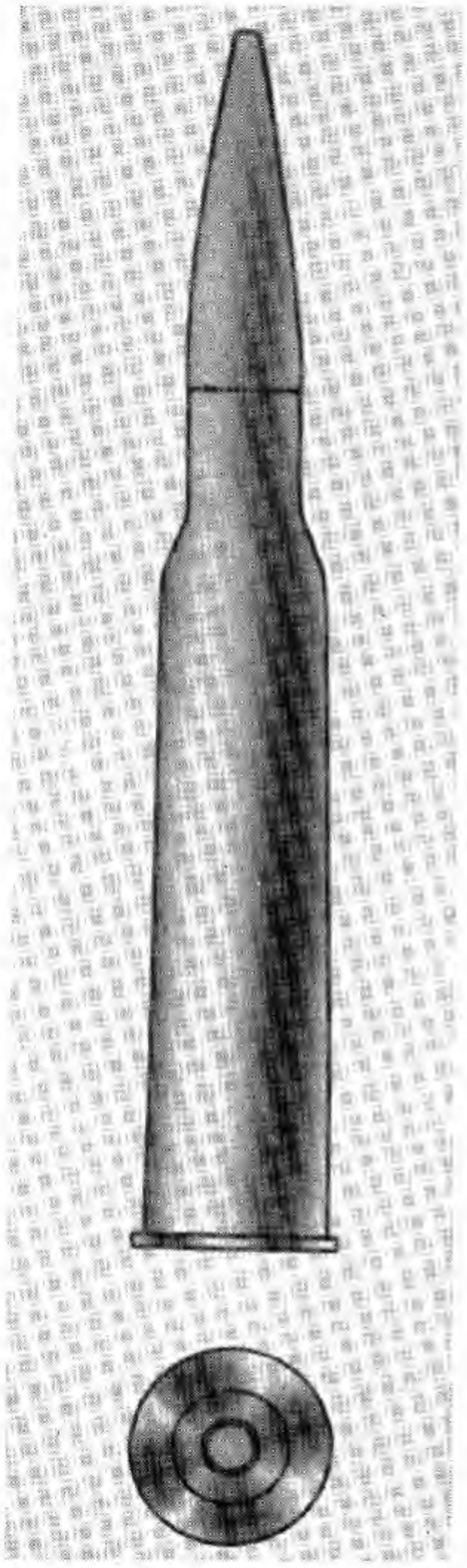

Figure 9–7. Artist's conception of the 12,7-mm rimmed cartridge used in the Shvak gun of that caliber.

23-mm Ammunition

There is a striking contrast between the Soviet 20-mm and 23-mm rounds used in World War II. The 20-mm was crudely designed and apparently produced in the utmost haste; the 23-mm exhibits features of refinement. The latter uses a bottle-necked case; and, although there is no distinct shoulder, the use of a belt just forward of the cannelure, or groove, serves to provide a mechanical stop to fix the extent that the round may enter the chamber. (See fig. 9–13.) The shape and dimensions of the groove itself follow the latest practice.

In the era just before World War II when emphasis began to be placed on increasing the explosive content of aircraft gun projectiles, several manufacturers produced 23-mm rounds which were merely versions of their 20-mm cartridges having the neck enlarged and fitted with a suitable projectile. Such changes generally had the result of lessening the effectiveness of the shoulder in positioning the round and adding materially to the possibility of lightly struck primers. The date of its appearance and its own physical characteristics indicate that the 23-mm VYa was designed specially for use with the 23-mm projectile and is not a converted 20-mm design. Figure 9–14 is a close-up of a fired case of this series.

In the years that followed World War II, the Russians produced a new gun in the 23-mm field, the NS. For this gun, the Soviets designed an entirely new series of ammunition with a case considerably smaller than that of the VYa. At the time this ammunition was designed, the major world powers were vigorously seeking higher velocities and increased performance, features which could not be credited to the NS round, with its absence of taper, poor shoulder, and lack of belt, shown in figures 9–15 and 9–16. The differences between the 23-mm rounds for the VYa and the NS are evident in figures 9–17 and 9–18. Unless the 23-mm NS cartridge is an interim round, it represents retrogression instead of progress.

37-mm Ammunition

The heavy load of propellant used in the original N 37 gun caused excessive stresses in engine and

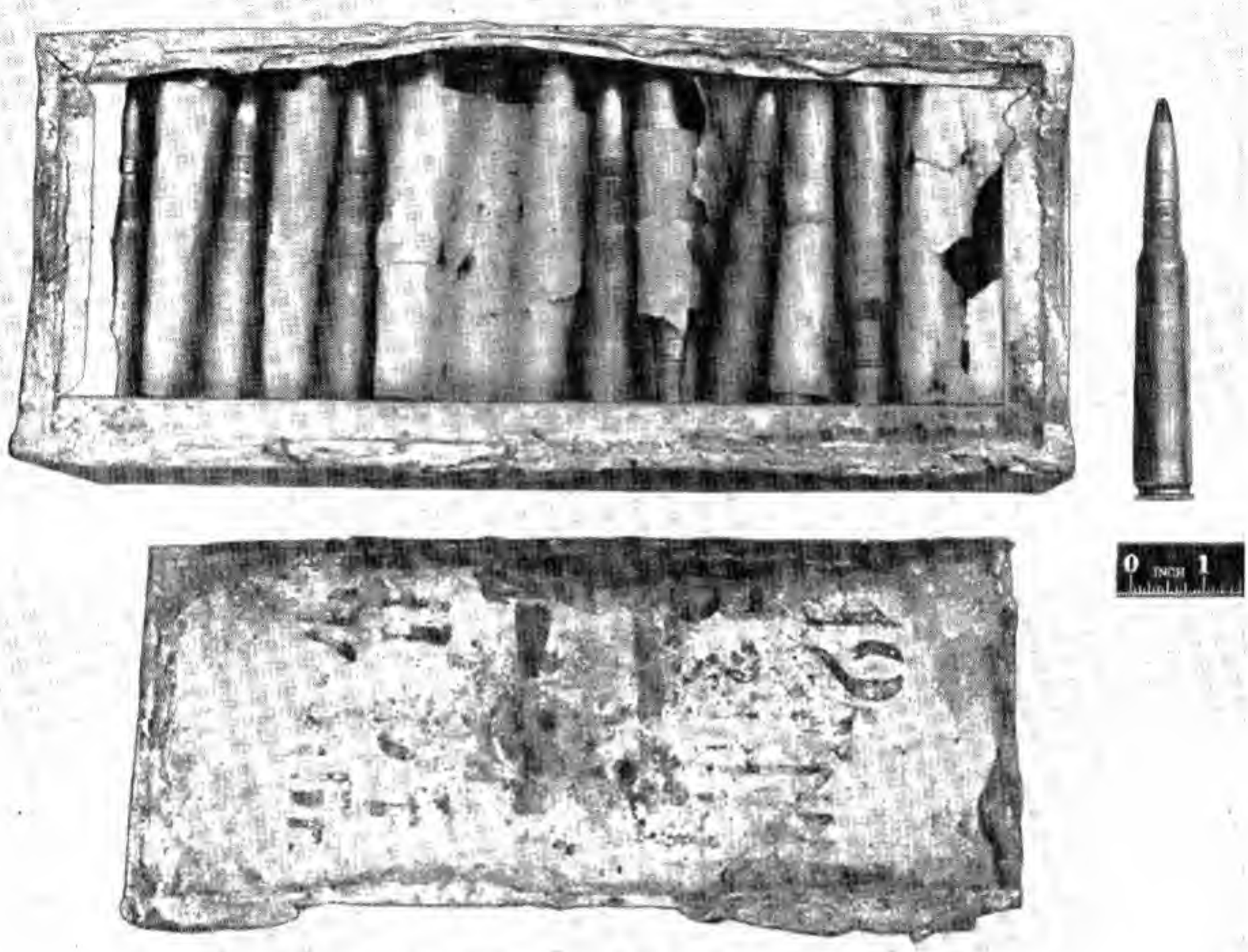

Figure 9-8. Method of packing Soviet 12.7-mm ammunition in bulk.

airframe. The dimensions of the NS 37 cartridge, shown in figure 9–19, indicate its unwieldy shape, which accounts for the stresses.

The refinement of the 37-mm gun which followed World War II included a reduction of the propelling charge, permitting the use of a smaller cartridge case. The smaller case, of course, permits shorter parts travel in the gun, but even more important it reduces the bulk of the ammunition. Figure 9–20 shows a fired case from an N 37 gun which was picked up in the Korean theater of operations.

Figures 9–21 and 9 22 are comparisons of base and profile of a representative group of Russian cartridge cases. The two specimens on the right, which are recent developments, indicate a trend toward a smaller cartridge. Although there is little taper and a rather vague shoulder, the construction of the base and the cannelure follow present trends. Design features of these cases indicate that they are the work of a single designer or group.

Links

The links used with these two rounds are the stripping type, as shown in figure 9–23. Withdrawal type links, shown in figure 9–24, are used in all the Shkas, Shvak, Beresin, and VYa aircraft guns. All four types illustrated were used in World War II. The rifle-caliber link used in the Shkas can be used in the DS and SG 43 ground guns as well as the aircraft gun for which it was designed.

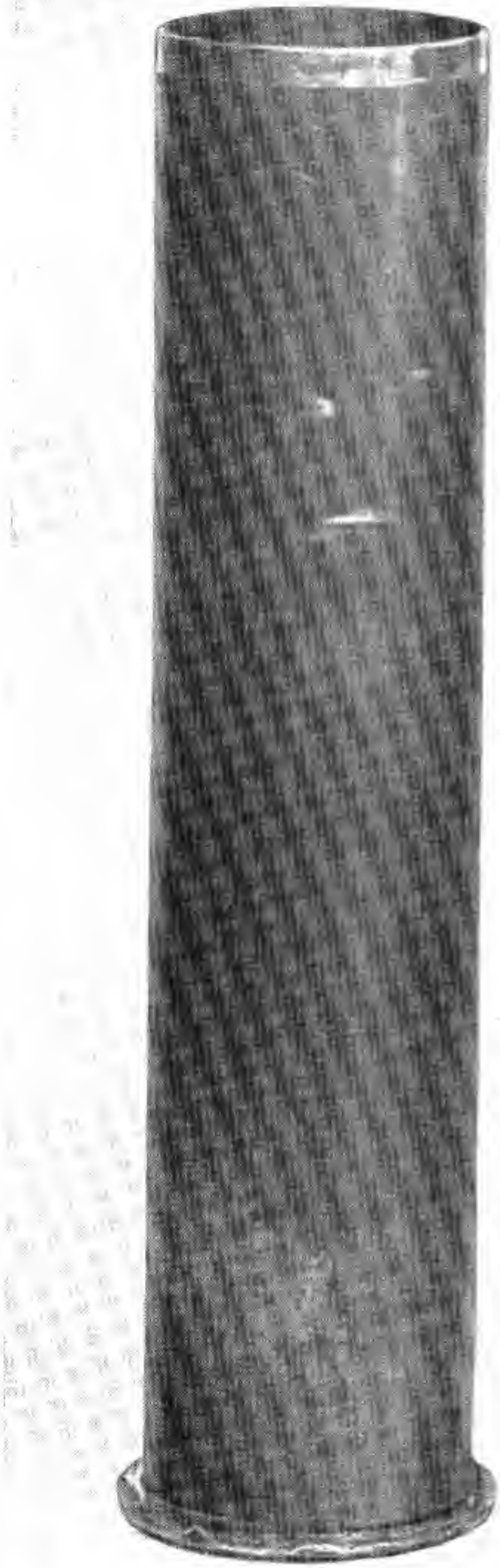

Figure 9-9. Close-up of a fired cartridge case for the 20-mm Shvak gun.

Figure 9-10. Soviet 20-mm complete round for Shvak cannon. (Round has been rendered inert at a U. S. proving ground.)

Figure 9-11. Bulk shipping containers for Soviet aircraft cannon ammunition. Top, 23-mm, and bottom 20-mm.

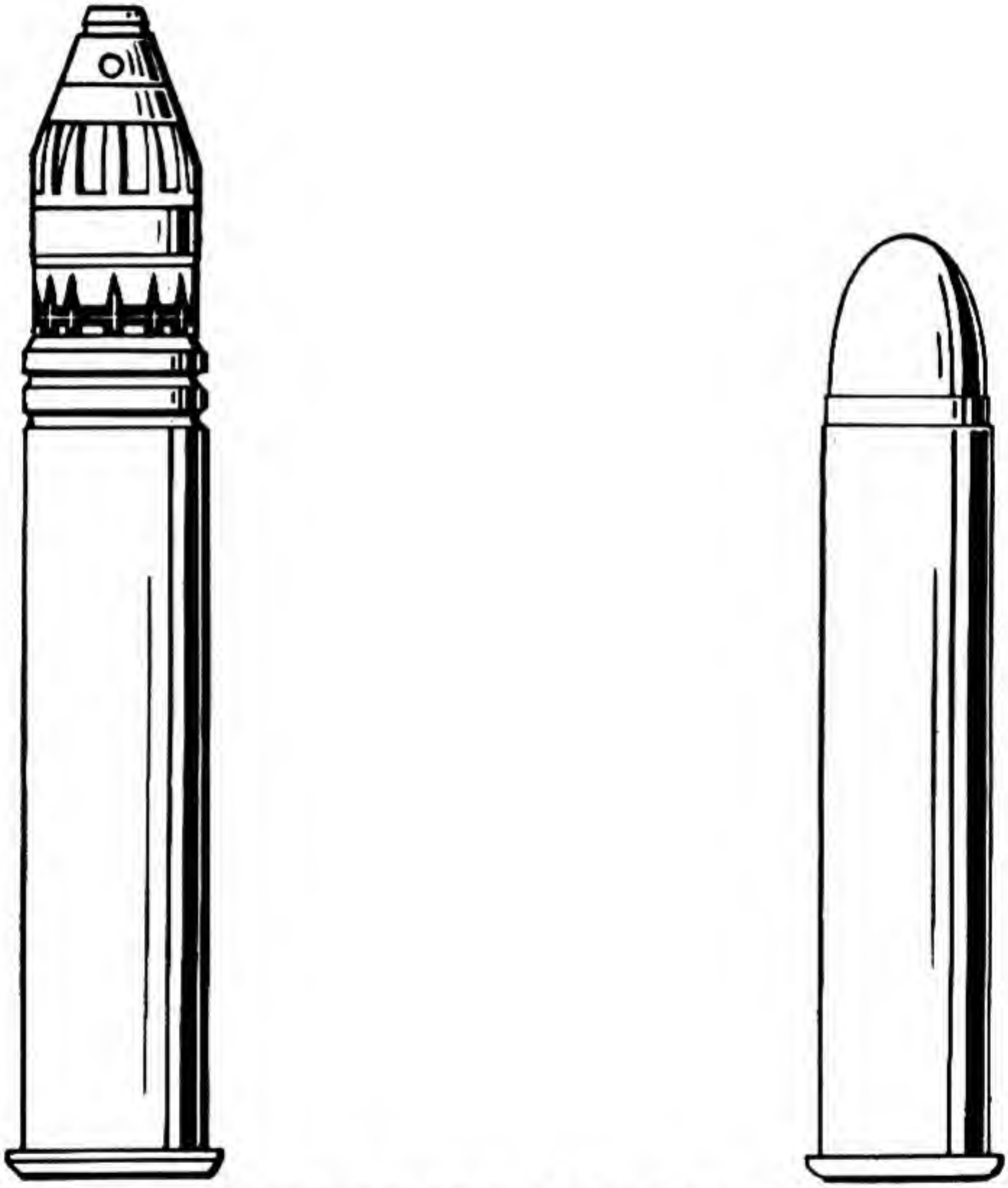

Figure 9-12. The 20-mm Shvak round compared with the old caliber .75 Gatling round.

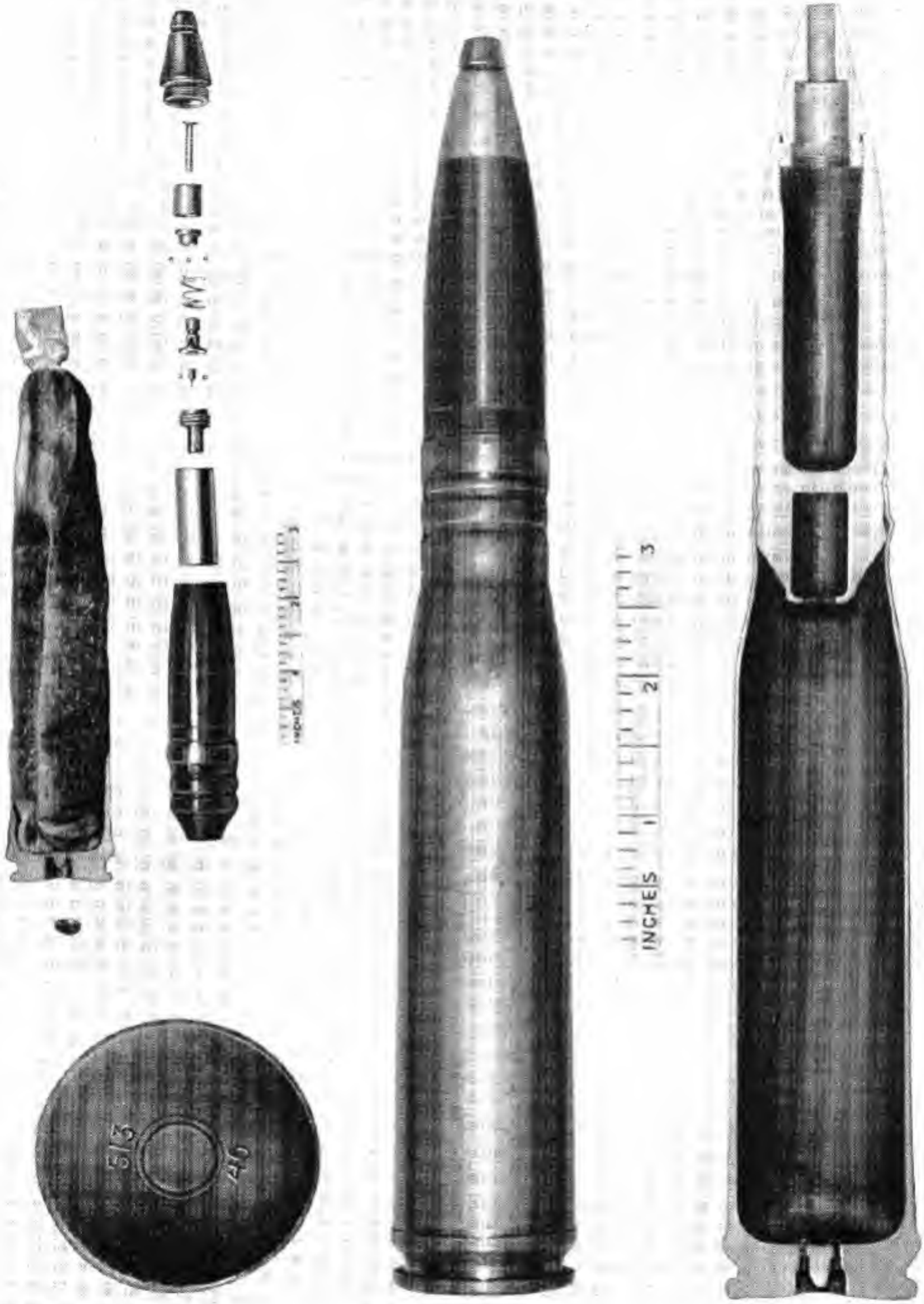

Figure 9-13. Study of a complete round for the 23-mm VYa cannon.

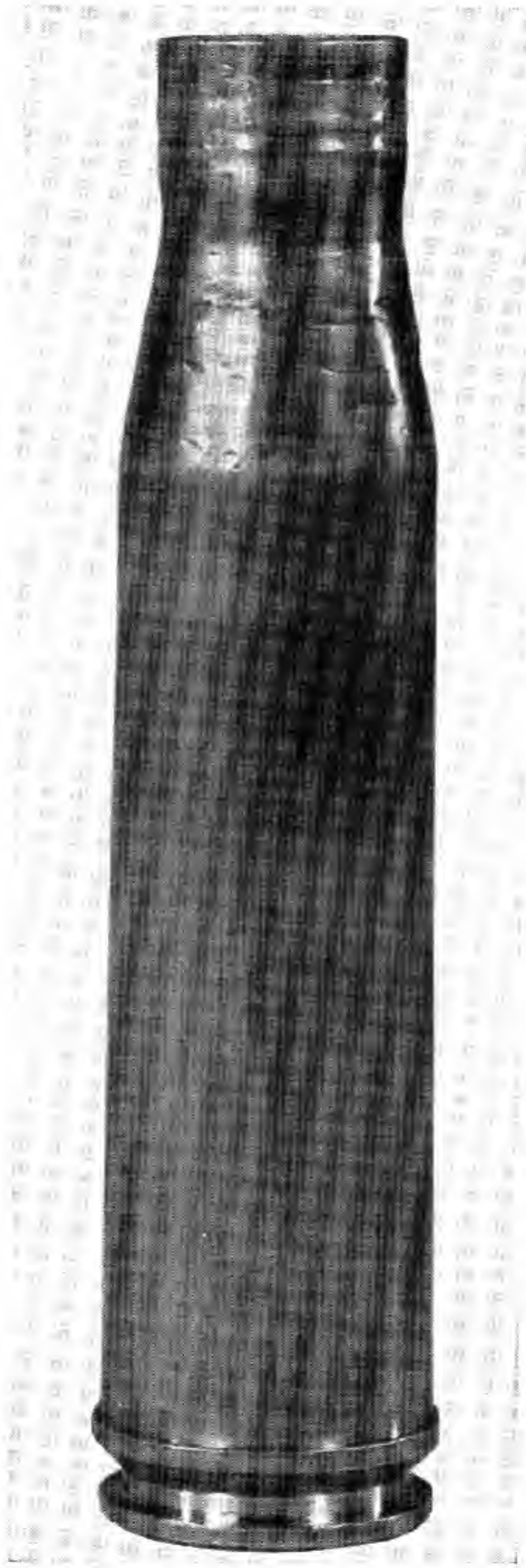

Figure 9–14. Close-up of a fired cartridge case for the 23-mm VYa gun.

Figure 9–15. Study of a complete round for 23-mm NS cannon.

212011°—52——14

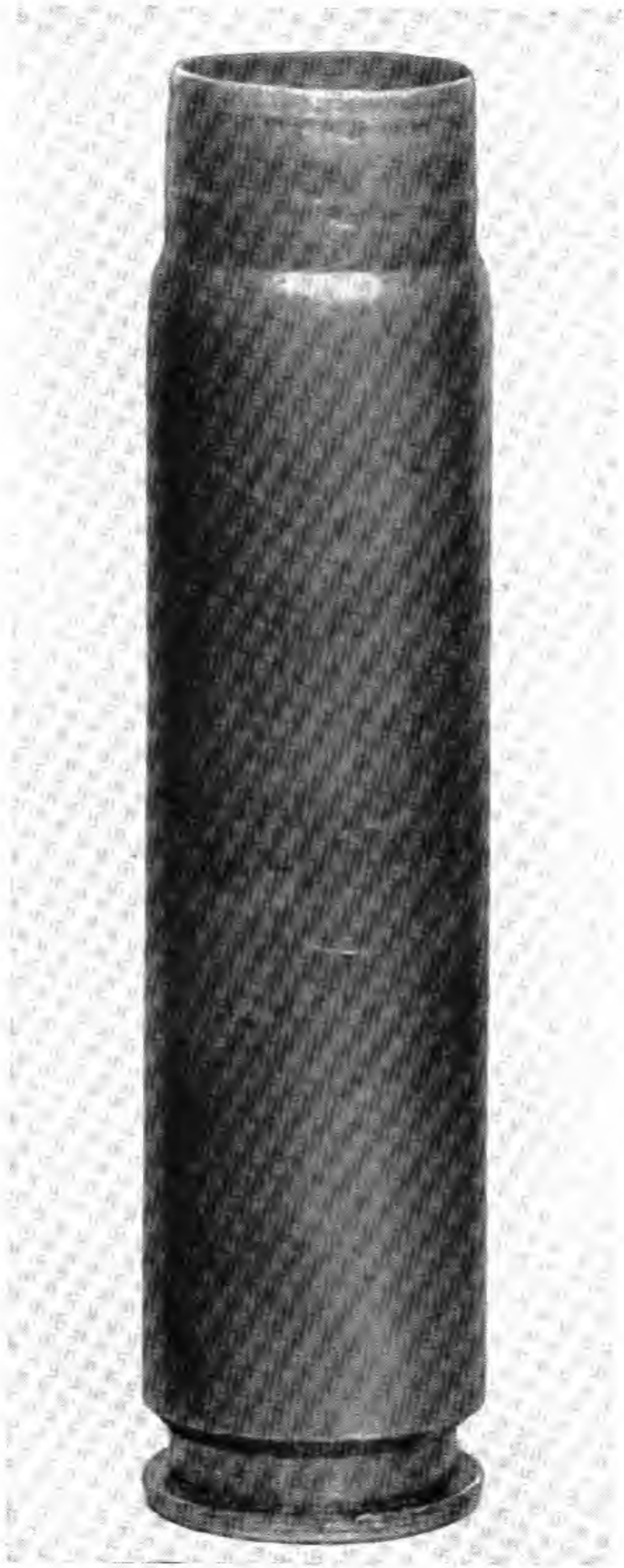

Figure 9-16. Close-up of fired cartridge case for 23-mm NS gun.

Figure 9-17. Comparison of Soviet 23-mm cartridge cases, both of which can use the same projectiles. Left case, old, for VYa type, right, new, for NS cannon.

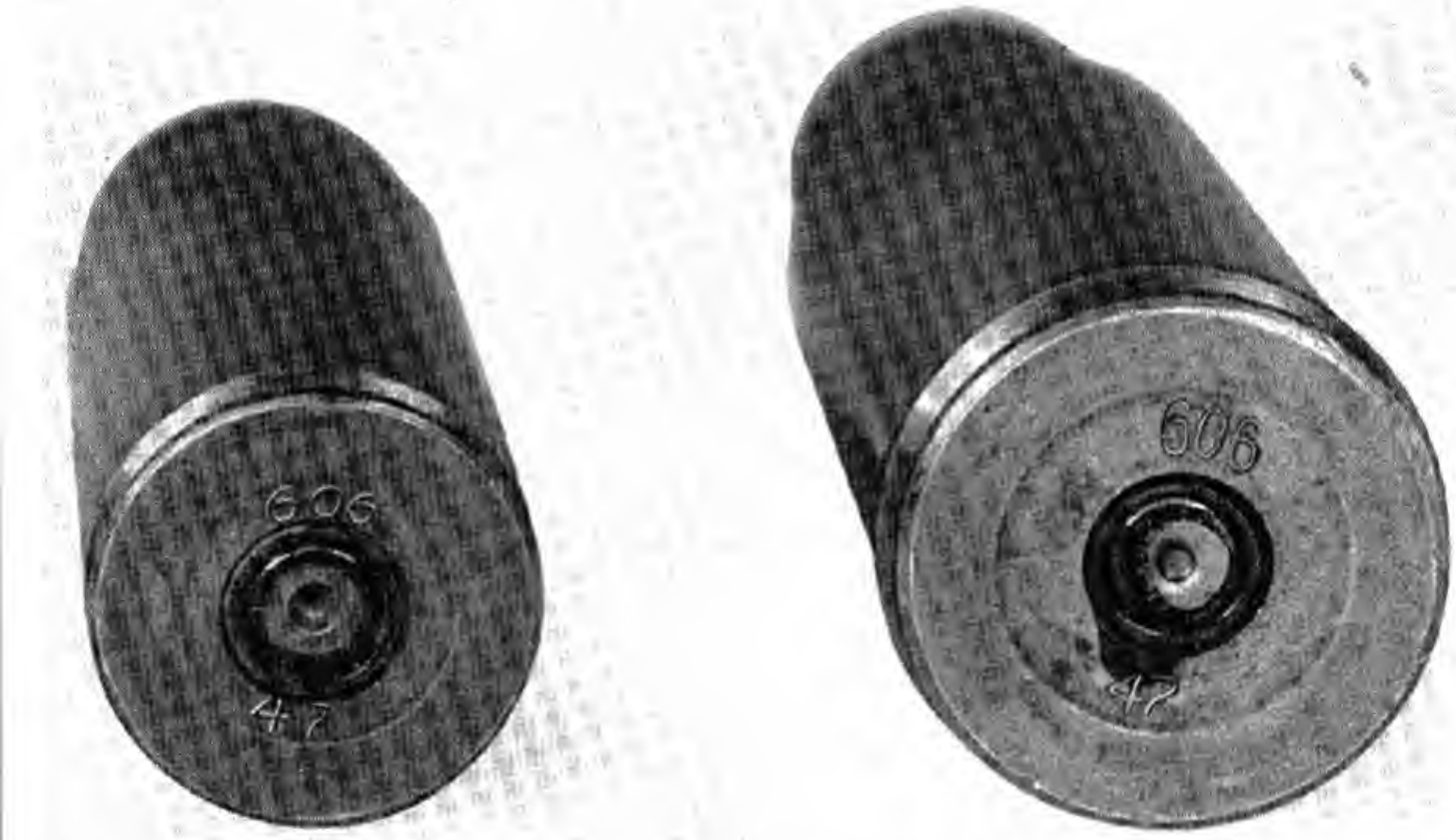

Figure 9-18. Markings on heads of Soviet 23-mm cartridge cases. Left NS, right VYa type.

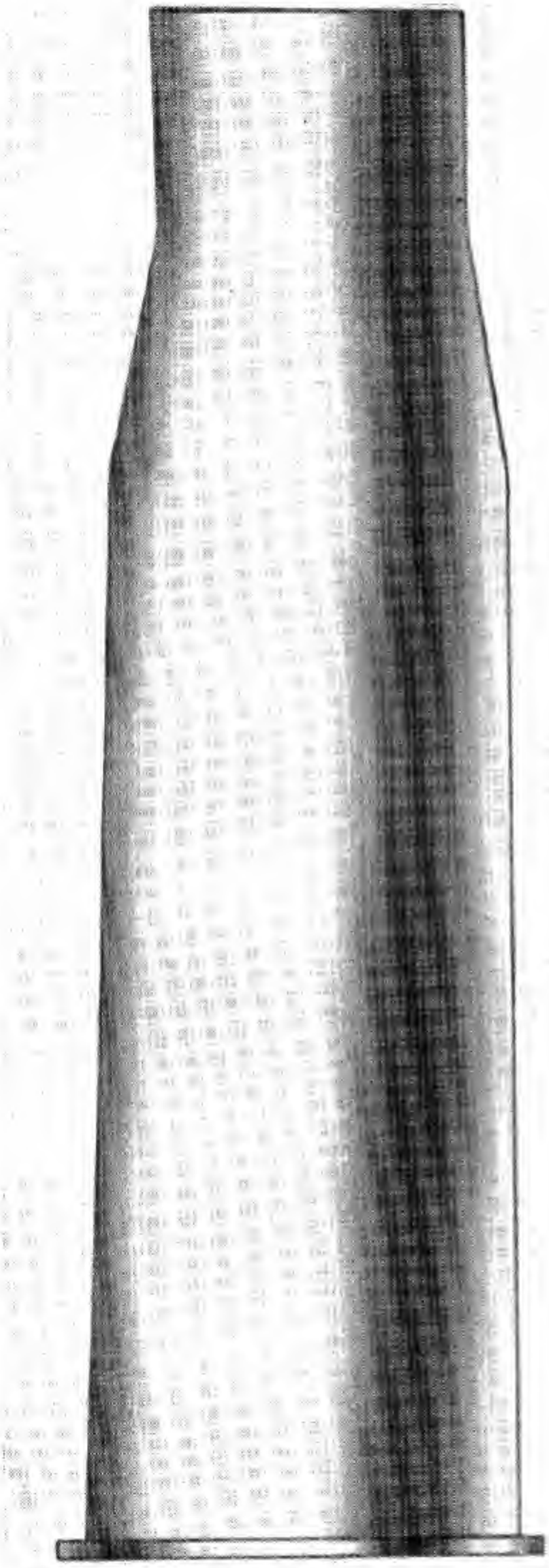

Figure 9-19. Artist's conception of cartridge case used in the old 37-mm NS cannon.

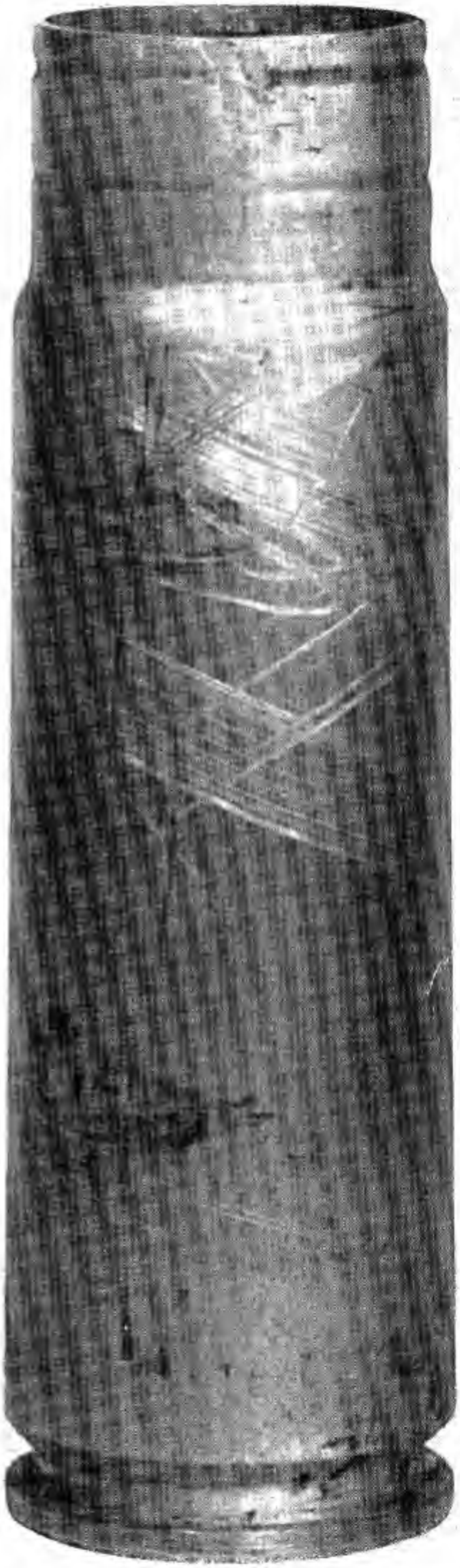

Figure 9-20. The new, smaller, cartridge case used in the 37-mm Soviet "N" gun.

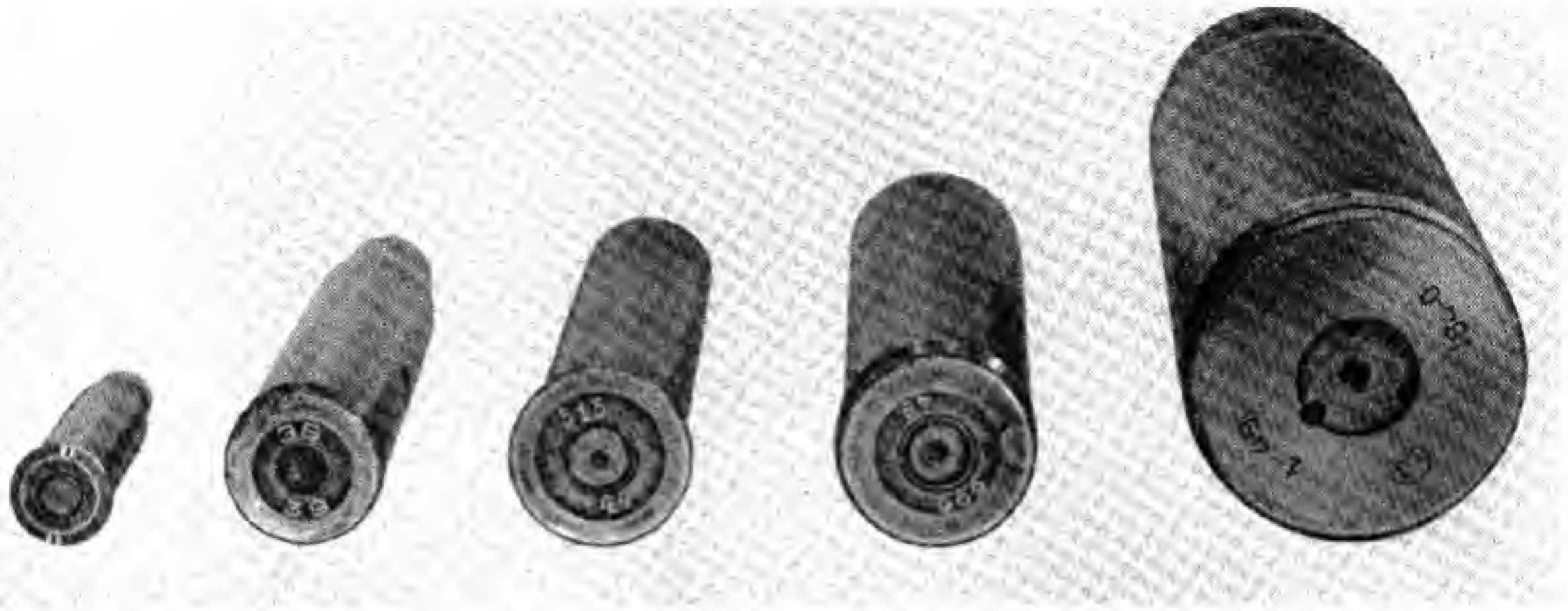

Figure 9-21. Comparison of typical Russian cartridge cases. Left to right: 7.62-mm, 12.7-mm, 20-mm, 23-mm (NS) and 37-mm (small).

Figure 9-22. Comparison of profiles of Russian cartridge cases. Caliber of each case is given in figure 9-21, above.

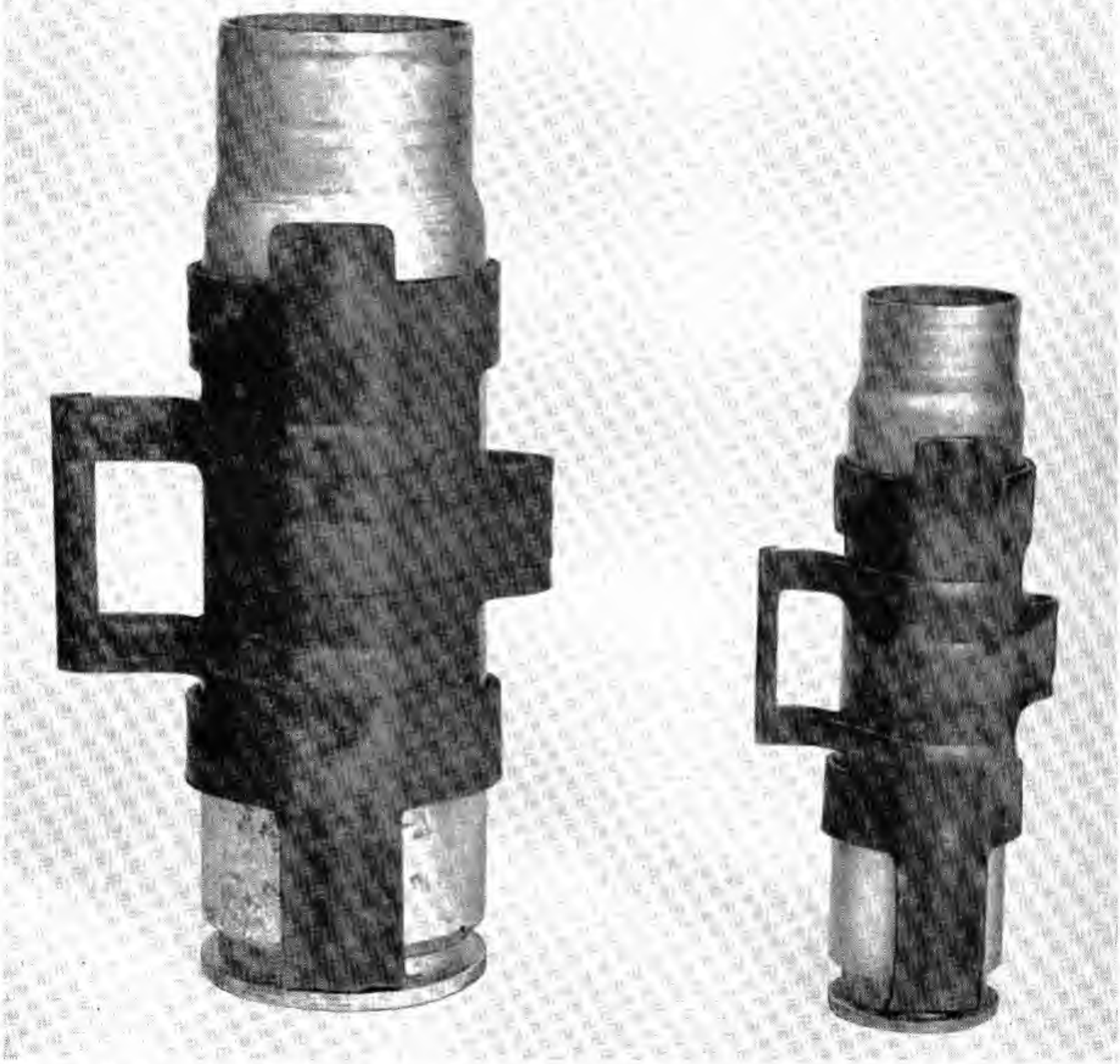

Figure 9-23. The cases and links for the new 37-mm and 23-mm Soviet aircraft cannon. Both cases are Nudelman designs.

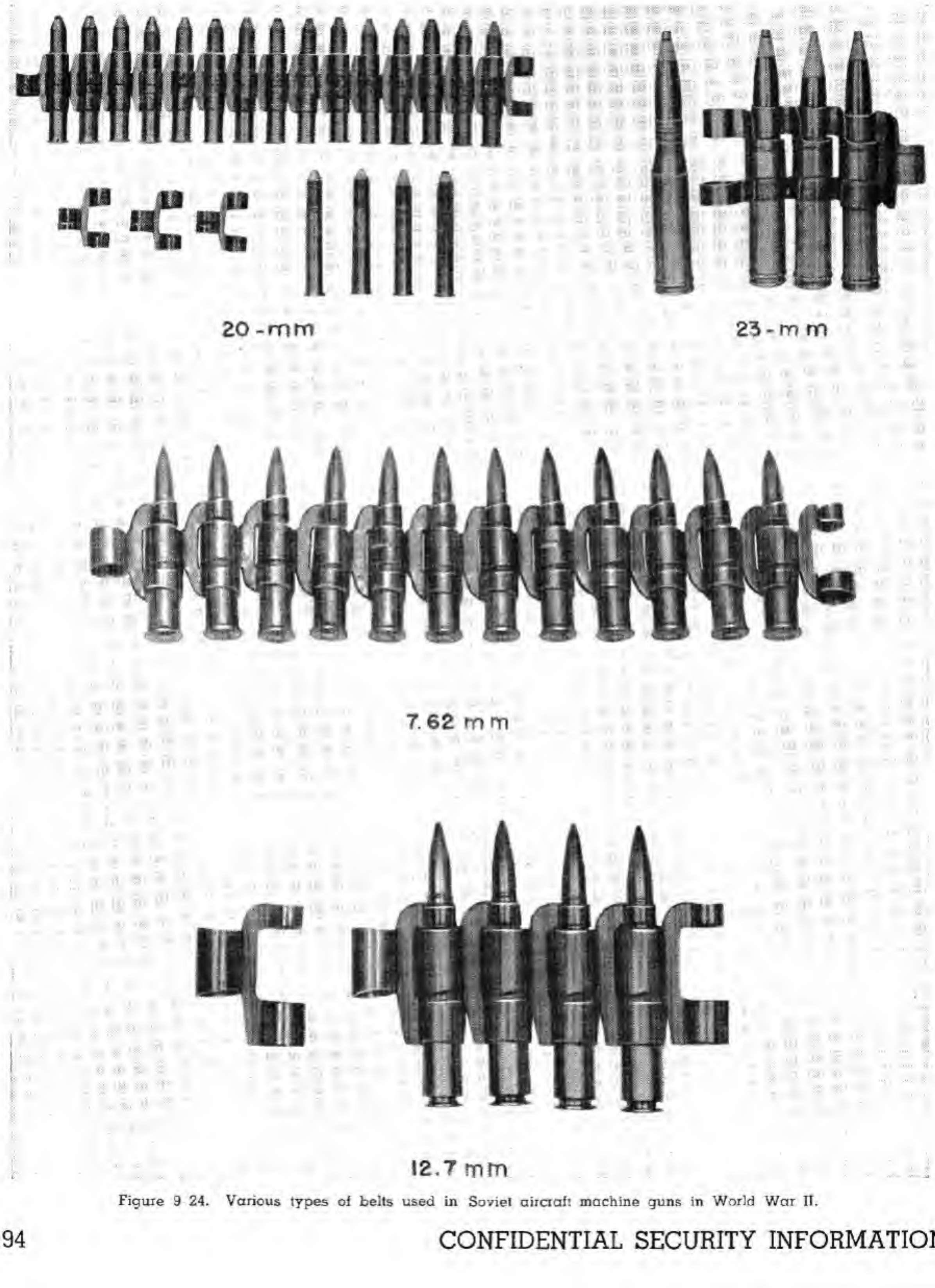

Figure 9-24. Various types of belts used in Soviet aircraft machine guns in World War II.

Chapter 10

SYMBOLS USED ON SOVIET MACHINE GUNS AND AIRCRAFT CANNON

Soviet machine guns and aircraft cannon are usually named for their designers. A short designation is devised by using letters from the name of the person credited with the design and some other identifying symbols, such as, some word or phrase from the name of the gun, arsenal mark, caliber, or year of manufacture. A table which follows explains some of the designations found on various Soviet machine guns, aircraft cannon, and related small arms.

This system was established after the Revolution and since the modern armament industry was established. Its flexibility has permitted it to remain unchanged as new weapons are added. In contrast, the system has been superseded in the West by the well-known number method of designation.

In the guns of the Degtyarev group, the serial number and the year may appear with letters of the alphabet. On most guns of this group, the marks are rather crudely stamped and are found on the top rear of the receiver.

The Shkas machine gun offers an interesting contrast. When it first appeared, in a peacetime period, high standards of finish prevailed. Each gun was carefully marked with the names of the inventors, the year of manufacture, the caliber, the serial number, the arsenal mark, and the type (such as wing, synchronized or flexible). Figure 10–1 shows this type of Shkas markings. Later guns, however, have been found with very poor standards of finish and markings crudely applied. On the other hand, the Shvak cannon (fig. 10–2), do not bear even the inventor's initials.

Code of Symbols Used on Soviet Machine Guns and Aircraft Cannon

Russian characters	English characters	Meaning in English
БС	BS	Beresin aircraft.
ДА	DA	Degtyarev aviation.
ДК	DK	Degtyarev heavy caliber.
ДП	DP	Degtyarev infantry.
ДПМ	DPM	Degtyarev infantry modified.
ДС	DS	Degtyarev heavy.
ДСхК	DShK	Degtyarev-Shpagin heavy caliber.
ДТ	DT	Degtyarev tank.
ДТМ	DTM	Degtyarev tank modified.
КП	KP	Wing machine gun (refers to Shvak).
МК	M–K	Maxim-Koleshnikov.
МТ	M–T	Maxim-Tokarev.
МП	MP	Motor machine gun (refers to Shvak).
НС	NS	Nudelman-Suranov.
ПМ	PM	Machine gun Maxim.
ПВ–1	PV–1	Machine gun Vickers.
ШКас	Shkas	Shpitalny-Komaritsky aircraft high-speed machine gun.
ШВак	Shvak	Shpitalny-Vladimirov.
СГ–43	SG 43	Heavy Goryunov 43.
СП	SP	Synchronized machine gun (refers to Shvak).
ТП	TP	Flexible machine gun (refers to Shvak).
УБК	UBK	Universal Beresin wing.
УБС	UBS	Universal Beresin synchronized.
УБТ	UBT	Universal Beresin flexible.
ВУа	VYa	Volkov-Yartsev.

Figure 10-1. Markings appearing on the top of a flexible Shvak machine gun.

Figure 10-2. Identification markingson an engine-mounted Shvak cannon.

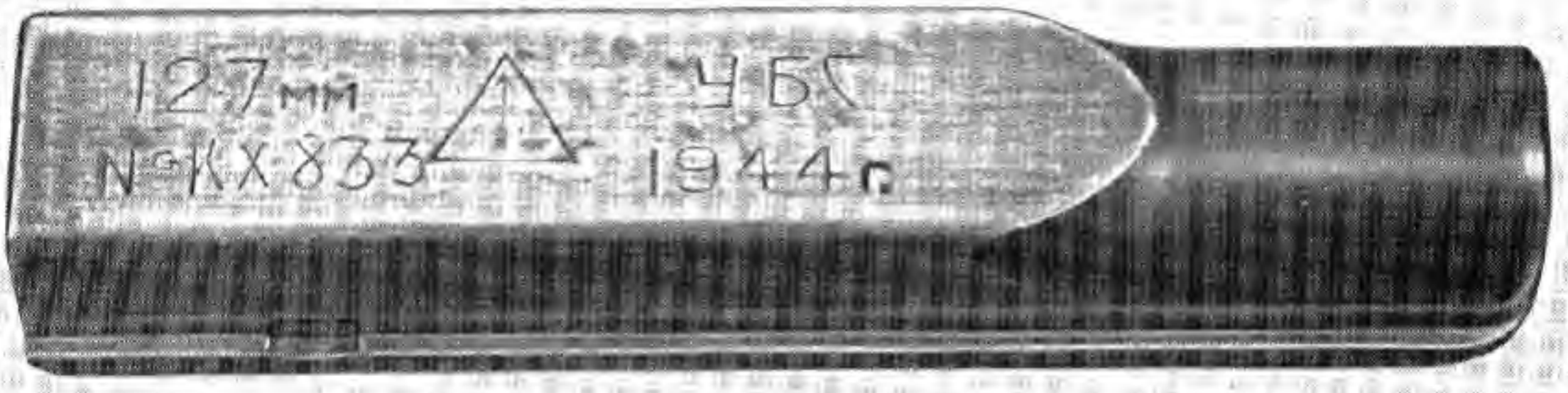

Figure 10 3. Markings on a 12.7-mm Beresin Aircraft Gun.

NOTE: MARKINGS SHOWN ARE FROM AN APPROXIMATE SKETCH, NOT AN EXACT FACSIMILE.

Figure 10-4. Copy of markings appearing on a Goryunov infantry machine gun captured in Korea.

Figure 10 3 shows typical markings on a gun of the Beresin family. Marking on this particular gun was done in two stages. It is evidently the practice to place the letter indicating the use (synchronized, turret, or wing) and the serial number at a late stage in manufacture, while the letter for basic information is placed earlier.

The Goryunov ground machine gun (fig. 10–4) is marked inconsistently. Some guns show the full name, some have initials, and some omit the designers entirely. Attempts have been made to explain these facts on grounds of political favoritism, but it may be that local conditions dictate more or less care in the marking operation, and specifications may be less rigid than in the Western countries.

The marking of a VYa cannon is shown in figure 10–5. In the early appearance of this weapon in the Korean operations, attempts were sometimes made to obliterate the identification. Such an attempt is shown in figure 10 6. It is evident that the purpose was to conceal evidence of Soviet origin of the cannon. To accomplish this purpose, the arsenal mark was crudely removed and the initials of the gun system were scratched off. All letters and figures remaining are common to the Russian and English alphabets. In figure 10–7 we see an even more thorough job along the same lines.

The Nudelman-Suranov 37-mm cannon produced during World War II have not only the initials of the inventors' surnames included in its marking but also the surnames spelled out in full on another line. This duplication is typical of the variety to be found in Soviet machine gun marking. Figure 10–8 shows the marking on an NS 37 gun.

The NS 23 is stamped with the initials but not the names. The example shown in figure 10–9 includes the serial number, caliber, and year of manufacture. (The un-synchronized, fixed version is similarly marked except that KM replaces CM after the 23.)

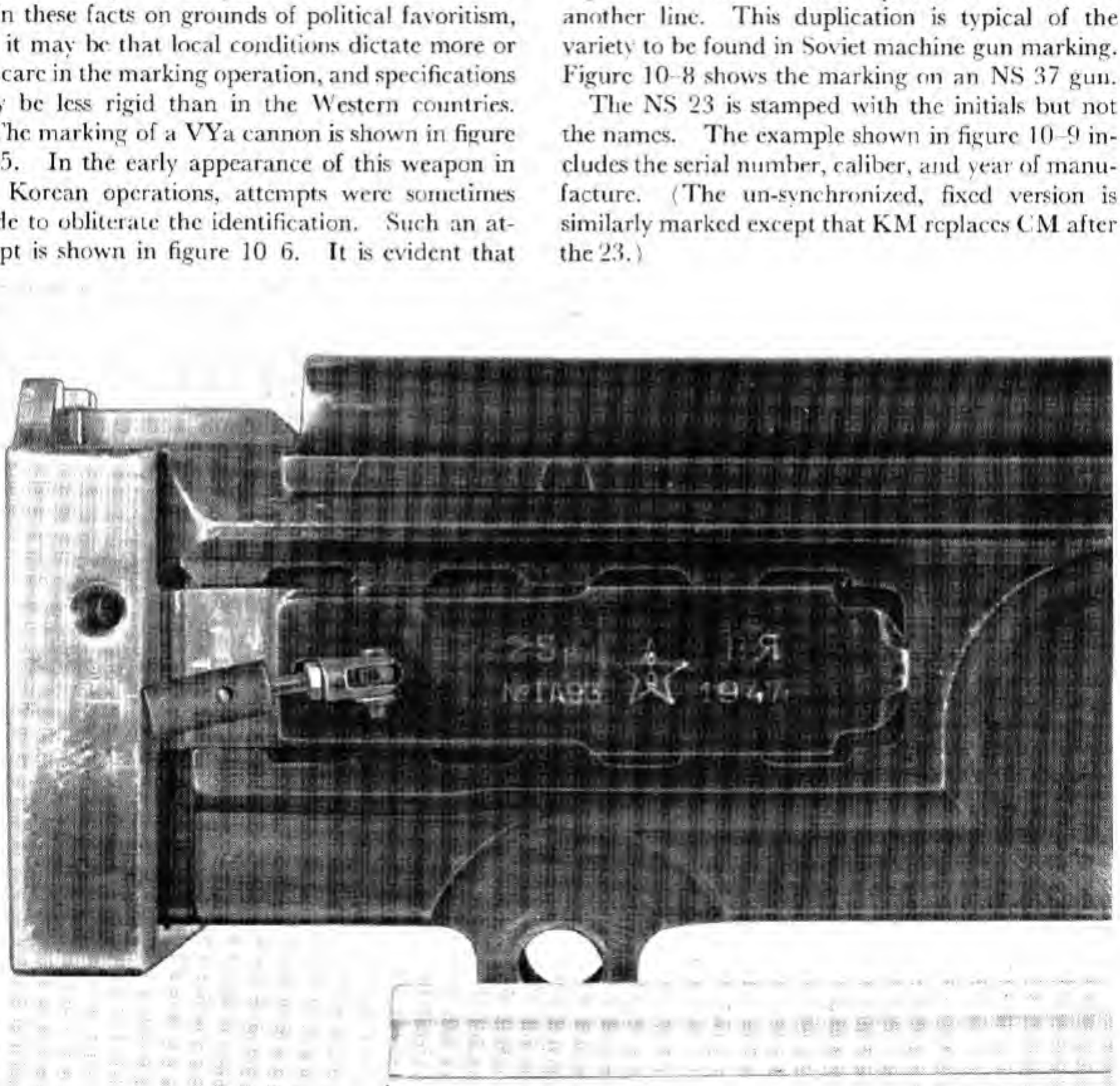

Figure 10–5. Complete marking from a 23-mm VYa cannon.

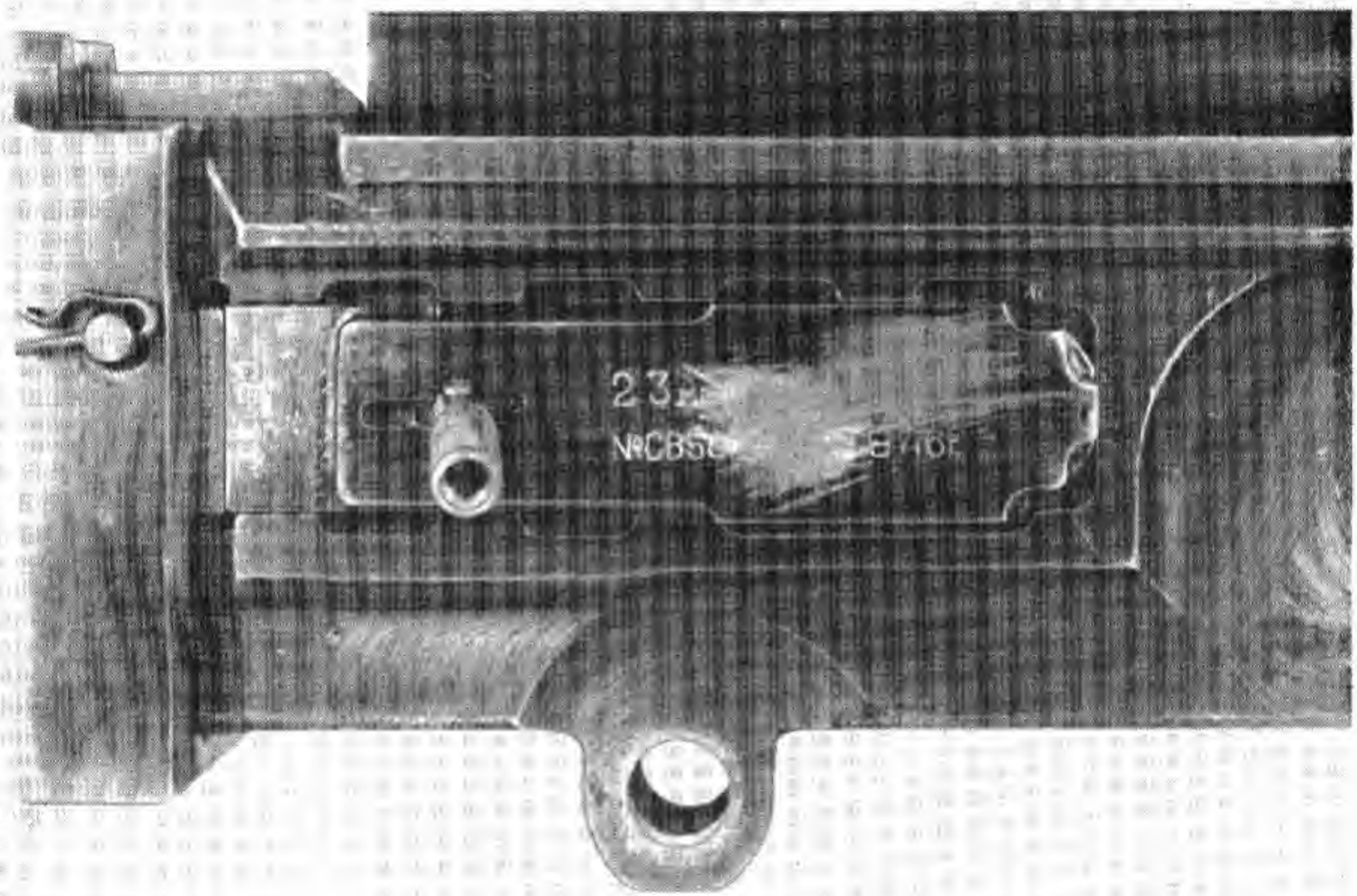

Figure 10-6. VYa cannon with marks crudely defaced. The arsenal mark and the initials have been obliterated.

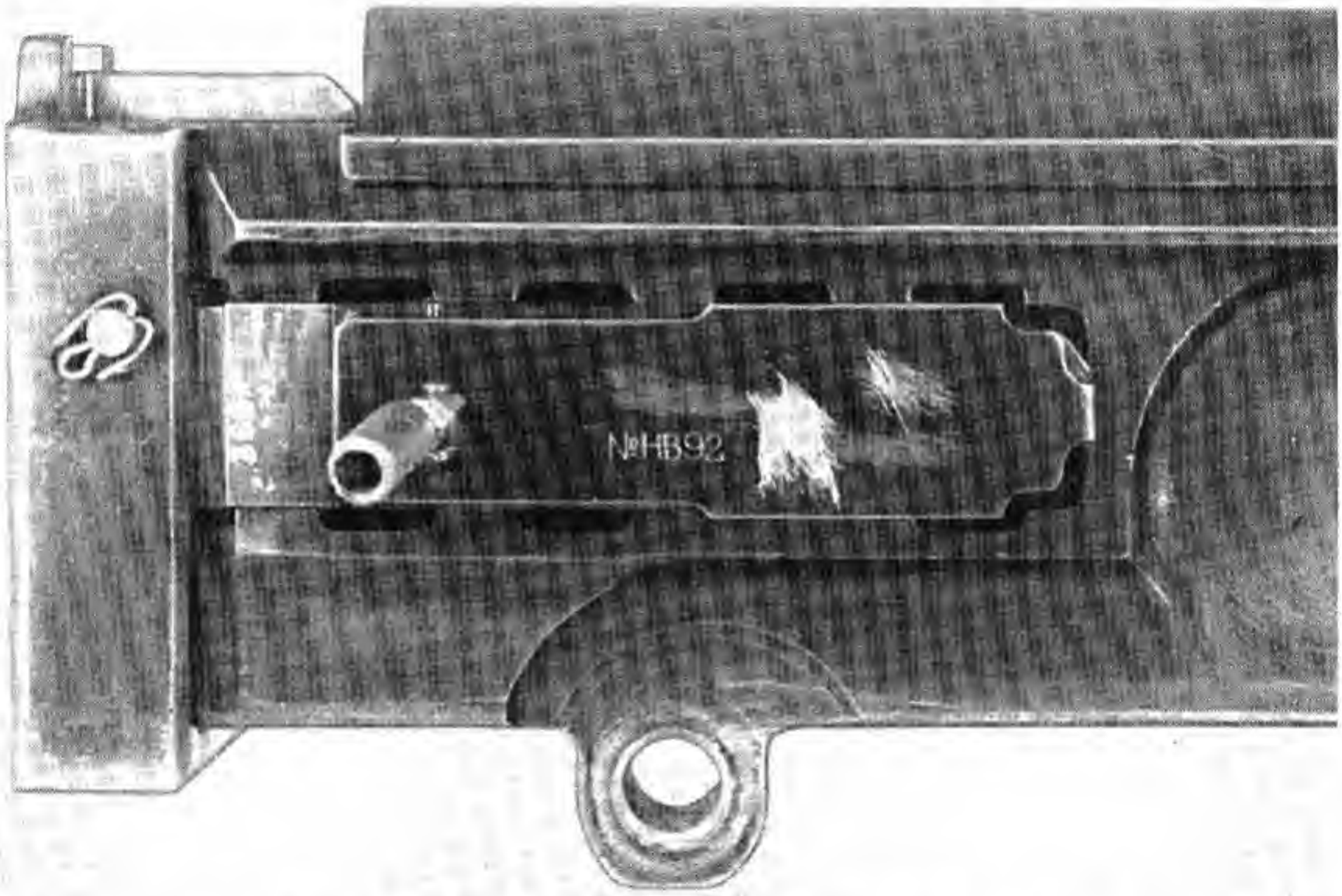

Figure 10–7. VYa cannon with all marks except serial number removed. As parts are not completely interchangeable, the serial number is critical for reassembly.

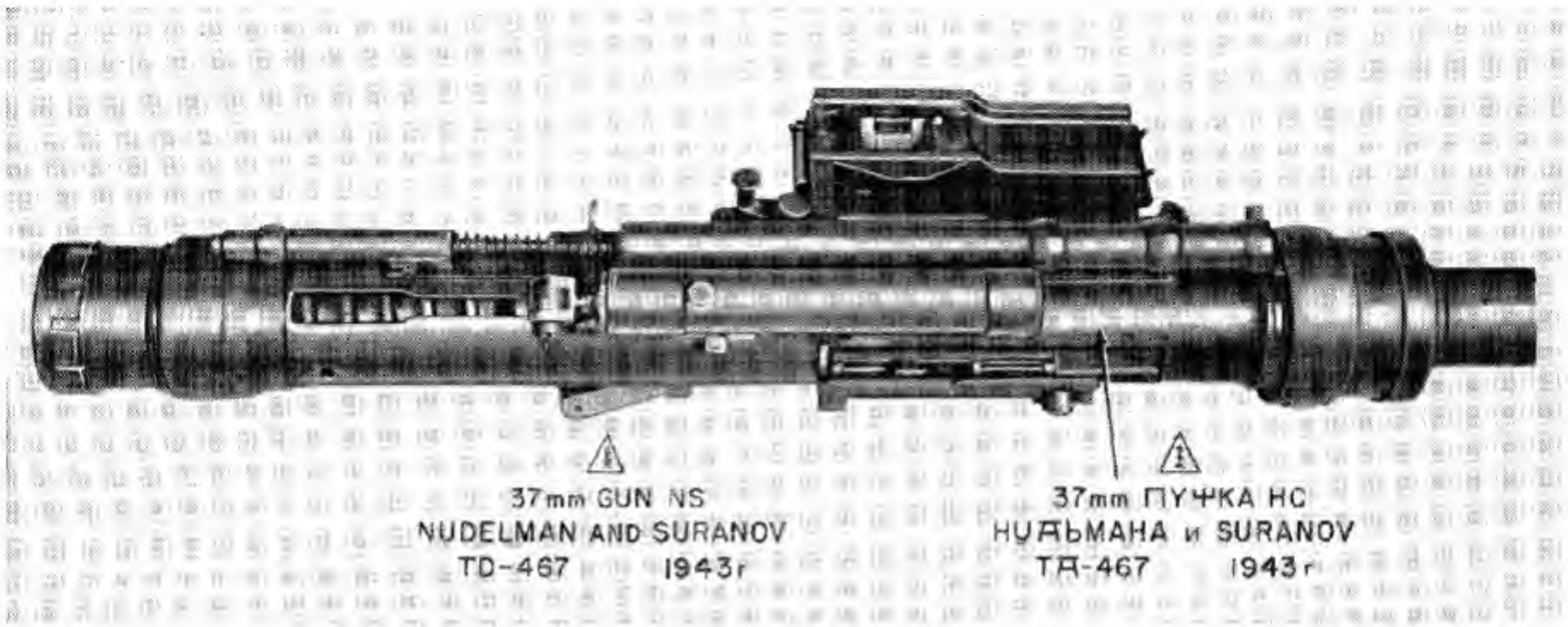

Figure 10 8. Typical marking of a 37-mm NS gun.

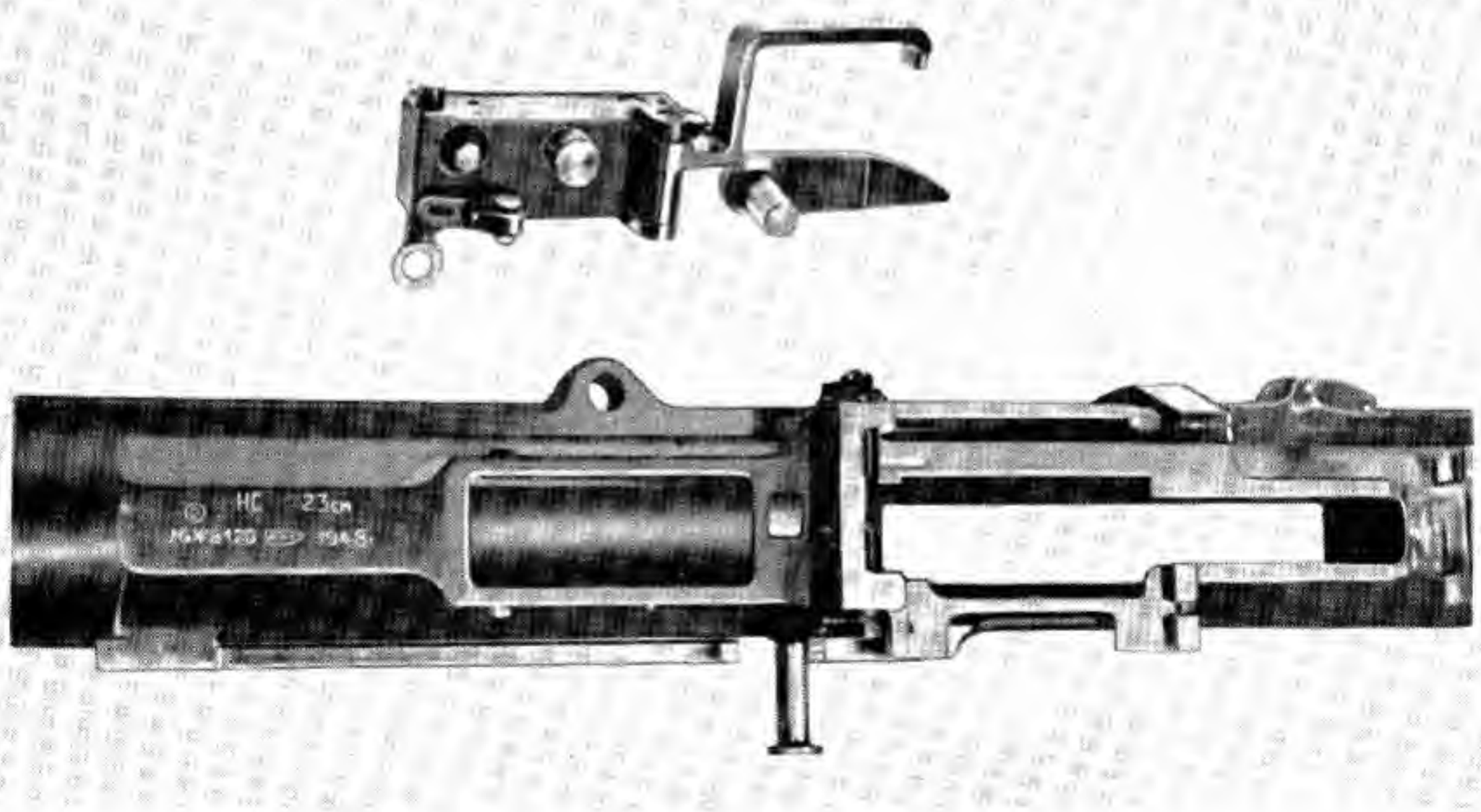

Figure 10–9. Mark of a 23-mm synchronized NS gun.

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